United States
Department of
Agriculture

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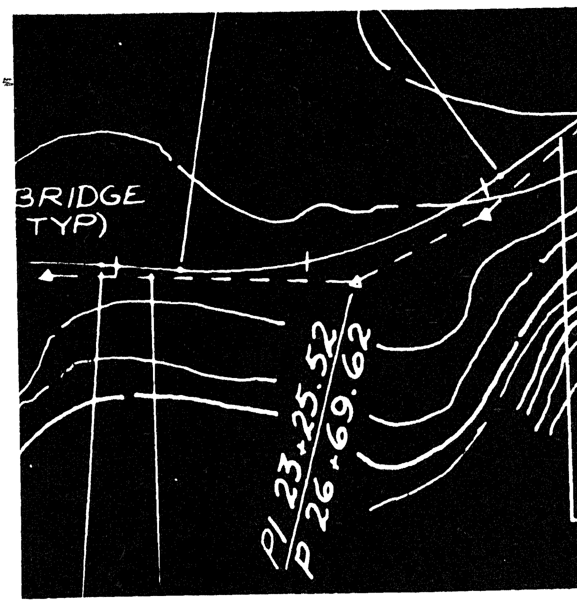
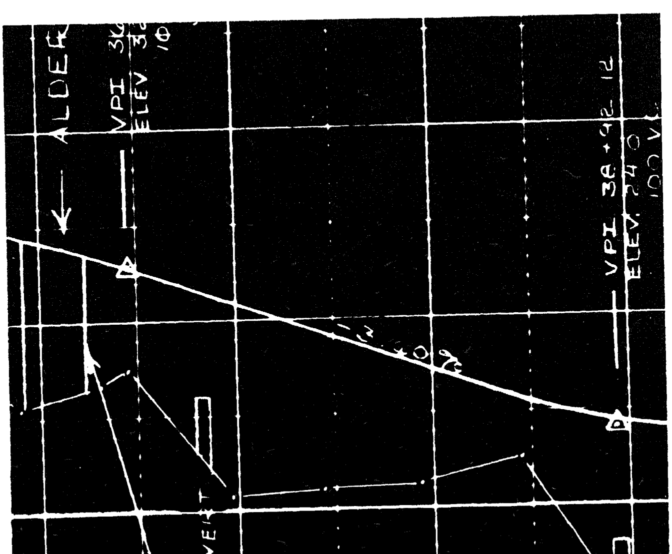
Alaska Region
Report 160A

Appendices to the DEIS: Road Access and Bulk Samplin at the U.S. Borax Quartz Hill Molybdenum Claims, Tongass National Forest, Alask





Appendices

to

DRAFT ENVIRONMENTAL IMPACT STATEMENT
ROAD ACCESS AND BULK SAMPLING

U. S. Borax Molybdenum Claims at Quartz Hill
Tongass National Forest, Alaska

Alaska Region Report 160A
November 1981

Lead Agency: USDA - Forest Service
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Cooperating Agencies:
- National Marine Fisheries Service
- U.S. Fish and Wildlife Service
- U.S. Army Corps of Engineers
- Alaska Department of Fish and Game
- Alaska Department of Community and Regional Affairs
- Alaska Department of Natural Resources
- Southern Southeast Regional Aquaculture Association, Inc.
- U.S. Bureau of Mines
- City of Ketchikan and Ketchikan Gateway Borough
- Alaska Department of Commerce and Economic Development
- Alaska Department of Transportation and Public Facilities

Comments on this draft EIS must be postmarked by January 29, 1982. Mail all comments to the above address.

LIST OF APPENDICES

APPENDIX A

SCOPING DOCUMENT

A SCOPING DOCUMENT
FOR
SURFACE ACCESS AND BULK SAMPLING
ON THE U.S. BORAX QUARTZ HILL
MOLYBDENUM DEPOSIT

INTRODUCTION

The Alaska National Interest Lands Conservation Act (the Act), as signed in law by the President on December 2, 1980, in part mandated several actions related to the U.S. Borax molybdenum deposit at Quartz Hill. As this depos is located within the Misty Fjords National Monument, requirements for the analysis of this project are very specific. Section 503(h)(3) directs the preparation, by the Secretary of Agriculture, of an Environmental Impact Statement (EIS), under the National Environmental Policy Act (NEPA) of 1969 which covers an access road for bulk sampling purposes and the bulk samplin phase proposed by United States Borax & Chemical Corporation in the Quartz Hill area. The draft of this EIS is to be prepared by December 2, 1981 and shall include but not necessarily be limited to:

1. An evaluation of alternative surface access routes which may minimize t overall impact on fisheries of both access for bulk sampling and mine development access;

2. An evaluation of the impacts of the alternatives on fish, wildlife, and their habitats, and measures which may be instituted to avoid or minimi negative impacts and to enhance positive impacts;

3. An evaluation of the extent to which the alternatives can be used for, the likelihood of each alternative being used as a mine development roa including the impacts of widening a road, realignments and other design and placement options; and

4. Plans to evaluate the water quality and water quantity, fishery habitat and other fishery values of the affected area, and to evaluate, to the maximum extent feasible and relevant, the sensitivity to environmental degradation from activities carried out under a plan of operations of t fishery habitat as it affects the various life stages of anadromous fis and other food fish and their major food chain components.

The Notice Of Intent To Prepare this EIS was published in the Federal Regis on February 19, 1981.

Paralleling the preparation of this EIS will be the preparation of a Concep Analysis Document (CAD), to be published in draft by June 2, 1981, analyzin several mine development concepts as directed in the Act, Section 503(h)(2) The purpose of that document is to provide information for use in this EIS identification of the most desirable road location, discussion of general

foreseeable potential environmental impacts of each mine development concept and studies needed to evaluate and otherwise address those impacts. These studies will provide valuable information at such time that the total mine development EIS is prepared.

Under NEPA, the first step in an environmental analysis is the scoping process. A paper is prepared to explain how this scoping process was conducted and document the results. The process is conducted by the Interdisciplinary Team (IDT) organized to perform the environmental analysis. There are three categories under which the various comments regarding the project are examined.

Public Issues: These are issues related to the project that the public identified through one of three ways:

(a) A formal public meeting was conducted at which time oral or written issues could be presented. All issues were recorded for review by the IDT.

(b) A preliminary list of issues and solicitation for additional written issues was mailed to approximately 500 organizations, groups and individuals.

(c) Concerned organizations, groups and individuals were invited to visit the appropriate Forest Service official to present or discuss issues.

Several methods, including local papers and radio stations were used to explain the ongoing process. Local media have featured this project in detail.

Management Concerns: These are identified by the IDT, U.S. Forest Service, and cooperating agencies. A preliminary list was circulated prior to a formal IDT meeting at which time the concerns and their implications were discussed in detail.

Opportunities: An effort is made to identify from all sources, potential impacts from the project that may be determined beneficial and therefore classified as opportunities.

In preparation of the EIS, much of the data assembly, identification of and development of alternatives and affects of alternatives on the environment will be conducted by a private consultant under contract for this analysis. This scoping document will provide important direction for their use.

PUBLIC ISSUES

The issues identified through public involvement dealt with the CAD, road EIS or both. Those that dealt solely with the CAD will be addressed in that analysis document and will be considered only in that context in this EIS. Those that may relate to both the CAD and EIS will be addressed in both documents as they apply.

There are some issues that cannot be resolved in either the CAD or EIS and will be addressed in detail at such time as an EIS is prepared for the tota mine development. Preparation of a mine development EIS will be one or mor years in the future. Some of those issues will be used in the CAD to ident studies needed for evaluation of mine development.

The issues have been reviewed by the IDT as to whether or not they apply to the EIS. Issues about how the CAD and EIS relate and will be incorporated have been discussed in the introduction and will not be dealt with any further. Those that do apply to the EIS were categorized as to which environment or activity is most heavily affected. The issues were then prioritized as to their perceived importance. The following discussion of alternatives will be by category and priority.

<u>ROAD LOCATION</u>

<u>Issue:</u> Forcing of IDT to choose least favorable route if best bulk sample route is one drainage and best mine development access the other drainage.

<u>Situation:</u> It is important to remember that both documents are to presen an unbiased evaluation of all impacts that bear on the road location. The IDT will then recommend a road location with t least anticipated environment impact overall. The final decision will be made by the responsible official, not the ID

<u>Issue:</u> Impacts the townsite will have on road location should be addressed in the EIS.

<u>Situation:</u> The townsite location, as well as all other mine components, will be addressed as completely as possible in the CAD analys which will provide input to be used in the EIS. As it is desirable to have both roads in the same location, the CAD analysis will be important in the EIS. The EIS will not directly discuss the townsite location or other mine componen

<u>Issue:</u> Concern as to what the purpose of the EIS is as there appears be agreement that the bulk sample and mine road should be on same location.

<u>Situation:</u> The CAD is not an EIS document as enough information is not available to complete an EIS on mine development. Therefore, the bulk sample access road EIS must be able to stand on its environmentally. Section 503 of the Act specifies that an EI will be prepared on the access road and bulk sample process a will include an evaluation of the likelihood and the extent o the access road being used as a future development road. The CAD is not an EIS, therefore does not go into depth in evaluating the effects of alternatives. There is no selectio criteria in the CAD that will result in identification of a recommended alternative. The access road EIS will therefore serve as the tool to evaluate alternatives and develop a preferred alternative.

Issue: Predetermination of mine development by location of the access road.

Situation: There is concern that once there is an access road for bulk sampling that the mine is a foregone conclusion or that the road will predetermine location of other mining facilities. The question of access is not an issue as it is a legal right of the mining claim holders according to mining law and the Act. Therefore, the objective is determining the location with the least adverse environmental impacts. The intent of the road access/bulk sample EIS is not to establish a precedent for mine development or determine final access or other mine development locations.

Issue: Concern as to how and when the bulk sample will be obtained and processed.

Situation: A complete description of the bulk sample process will be included in the introduction of the EIS. In the EIS document the process will be analyzed thoroughly to determine effects on the environment.

Issue: Impacts of the dock site should be considered in the EIS.

Situation: As a part of the development associated with bulk sampling access the location of a dock facility should be addressed. This facility may or may not conform to the location of the mine development port facility depending on final location and resource impacts specific to the individual needs of each operation. The EIS will not specifically discuss the mine development port facility.

Issue: Concern that 1981 data is used in the EIS.

Situation: It is important that all available data be used in analysis of the road location. The baseline data gathered in the 1981 field season will not be summarized in time to use in the EIS due to tight time constraints. Some raw data may be used if appropriate. Information from field work by the consultant and Forest Service personnel will be gathered to provide usable information for the EIS.

Issue: Impacts of possible abandonment of the project after the bulk sample phase should be considered.

Situation: The EIS will identify mitigating requirements that would be required if the project is abandoned. These measures would include such things as removing temporary drainage structures, construction of water bars and other erosion control structures, and removal of temporary buildings. It is not possible to return the road to its original condition, however the road would be revegetated over time if abandoned.

WILDLIFE

Issue: Adverse effects of road construction and bulk sampling on lo wildlife populations.

Situation: There is concern that local wildlife species, especially goa brown bear and waterfowl may be adversely impacted by habita displacement or disturbance from a variety of activities. T EIS will evaluate the magnitude of these impacts and how the compare by alternative.

WATER RESOURCES

Issue: Potential adverse impacts on freshwater in Keta or Blossom w need to have mitigating requirements.

Situation: There are potential adverse water quality impacts that may result from road construction activities and bulk sampling operations. Possible adverse impacts will be identified dur the EIS process and where needed, mitigating requirements wi be specified. Mitigating requirements are a standard compon of the EIS.

MANAGEMENT CONCERNS

These concerns were identified by solicitation from several agencies and participants of the IDT. The IDT reviewed them for relevance to the EIS a in the process identified additional concerns. As with the public issues, some concerns dealt only with the CAD, EIS or both. The Concerns identifi below are those that can be directly related to the surface access EIS. T related to the CAD will be addressed in that document.

FISH HABITAT

Concern: Direct effects of road construction on streams, such as eros from disturbed areas, or changing stream flows.

Situation: The road, in either the Blossom or Keta drainage, has potent for adverse impact to fish habitat. Studies since the 1977 have dealt primarily with construction of a access road with emphasis on the Keta drainage. This EIS will look at both drainages equally and consider the impacts of building a ful development road plus any additional width needed for pipeli corridor on stream fish habitat.

Concern: Possible adverse effects on fish habitat resulting from stoc piling rock materials, processing bulk samples or drilling a construction of adits. Effects may be either direct or thro ground water.

Situation: The bulk sampling process will result in removing a quantity of ore and processing a specific amount to be shipped for milling studies. The balance of the ore will have to be stored. The sample will be removed from adits which have the potential of draining substantial amounts of groundwater. The EIS will investigate the potential for detrimental effects to fish habitat by either direct surface drainage or ground water contamination.

Concern: Potential adverse effects can possibly be minimized through construction techniques and schedules.

Situation: There are construction techniques as well as timing requirements that can be identified and required to minimize adverse impact to fish habitat. The EIS will identify these and include them in mitigating measures.

ROAD LOCATION

Concern: Influence of the road location on siting of a townsite and port facility if the development proceeds.

Situation: It is felt that the access road location can heavily influence the siting of a townsite or port facility in the final mine development concept. It is desirable that both roads be on essentially the same location. Therefore, it is important that the results of the CAD be incorporated into the EIS route evaluation. The likelihood that the recommended route may be used as final development will be discussed in the EIS.

Concern: Susceptibility of routes to land slides, avalanches and floods.

Situation: Both drainages present very difficult road construction problems due to rugged terrain. Avalanche and landslide problems have played a large role in past evaluations and the recommended development concept of U.S. Borax. It is felt by the IDT that equal information is not available on both drainages and there is a need for further field studies and review of existing data. The EIS will reflect an analysis of adequate data for both drainages.

Concern: Location of cuts and fills, maximum grades, curve radii and other engineering requirements. Locating a single lane bulk sampling access road such that -- if development proceeds -- it can be converted to a 34-foot project road and adjacent utility/pipeline corridor with the least environmental impact.

Situation: The basic concern is the construction of a road in either drainage that will stay in place, offer safe access, have minimal impact, and be in the approximate same location as the permanent mine development road. To accomplish this goal, a systematic reconnaissance and location will be accomplished for both drainages, and the preferred route in each drainage identified. A location report detailing the various possible routes will be prepared. This report will contain and justify: (1) Design criteria for both mine development and bulk sample roads; (2) preferred and alternative locations for both roads on both drainages; (3) detailed descriptions of the preferred route on each drainage including, (a) "station by station description" of the routes, (b) areas which will constitute major design problems on either of the preferred routes and possible construction solutions to them, (c) general geotechnical review of each preferred route and, (d) a detailed cost for (1) construction of a single lane bulk sample road on either of the preferred routes (2) the cost of a mine development road on either of the preferred routes (3) future maintenance costs on either route.

This location report should reflect detailed information from on the ground activities so that only minor changes are necessary on either of the preferred routes prior to construction of the access road. Due to the time constraints a complete survey and design will not be available and costs involved would not make that practical prior to route selection. However, as certain critical areas are identified -- those associated with extreme steepness, slides, avalanche areas, critical rock structure, etc. -- it is desirable that detailed enough surveys be made in these areas so that probable road impacts may be determined.

The CAD input and finally the EIS will result in a recommendation of the best feasible road location where both the sampling and mine location road may be built.

Concern: Choosing a road location now that will limit impacts to only one of the two access corridors.

Situation: One of the major concerns is that regardless of which drainage is impacted, it is desirable that only one drainage is used for road access for the sampling and mine development. The CAD should provide sufficient information to the IDT so as to determine the most likely location that will accommodate both roads. If it is impossible to build a mine access road in one of the drainages, that information must be known in time to incorporate into the EIS.

Concern: Potential effects from a campsite for road construction and log dump site for shipping of timber removed from road right-of-way.

Situation: There will be a need for a construction camp for housing of people associated with road construction. The people associated with the bulk sample phase will likely stay at the Quartz Hill base camp which will require some expansion. Timber removed from the road right-of-way will require a salt water dumping site and storage area. These sites will be identified and evaluated in the EIS.

RECREATION

Concern: Impacts on recreation opportunity levels due to increased use from personnel and operations of the bulk sample process.

Situation: It is felt that impacts from the added population associated with this project will change the recreation opportunities and experience levels. Direct impact of the bulk sample access road and sampling process will not approach the magnitude of the total mine development. The EIS will not directly analyze the total development impacts but as it is desirable that both road locations be the same, input from the CAD will be important to the EIS. There may be distinct differences in recreation impacts to surrounding wilderness, fish and wildlife populations, etc., for both drainages and associated fjords. There is a feeling that a townsite location and resultant recreation use will substantially effect the fisheries and wildlife. It is important that the CAD provide information for the EIS related to the most suitable townsite or campsites available as well as the total human impact associated with a townsite and access for each drainage. Impacts on recreation experience levels include aircraft and boat traffic, noise levels, dust and smoke and visual aspects of the entire operation.

WATER RESOURCES

Concern: Increases in suspended sediments and turbidity of surface waters from construction activities.

Situation: Road construction and sampling process will produce sediments that can be carried by surface waters. The extent of this and measures that can be taken to minimize the impact will be discussed in the EIS. There may be considerably different sedimentation and turbidity impacts associated with each drainage that need to be identified and considered in evaluation of alternative routes.

Concern: Impact of road construction on 100-year flood plain.

Situation: Executive Order 11988 contains specific direction dealing in location of improvements within the 100-year flood plain. To the extent required, these directions may have to serve as parameters in the selection of the access route.

Concern: Mass movement of unstable soils due to construction activities.

Situation: There is concern that impacts of road construction on unstable soils or extremely steep slopes be addressed. There will be need for further soil investigation as alternative routes are examined. Soil investigations would go hand in hand with geotechnical surveys.

OPPORTUNITIES

Opportunities are issues or concerns which may have beneficial effects or advantages from implementation of the project.

Operations associated with the road construction and bulk sample removal will result in opportunity for increased local employment.

Completion of the bulk sample removal and testing will provide valuable information for assessing impacts of the final mine development proposal.

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J. S. Watson

J. S. WATSON
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4-6-81

APPENDIX B

ENGINEERING
RECONNAISSANCE REPORT

By

DAMES & MOORE
and
SVERDRUP & PARCEL AND ASSOCIATES, INC.

FOREWORD

This reconna...ce report for mine access road routes is submitte partial fulfillment of the Agreement between the U.S. Forest Servic Dames & Moore.

The report presents the results of a reconnaissance of two alter .ive access road routes to the proposed Quartz Hill Molybdenum Mine

It should be emphasized that this report addresses itself primaril engineering aspects of mine access road development. Environmenta pects are noted only when they obviously affect road engineering or con :ructibility. It is acknowledged that environmental impacts are a nportant consideration when comparing alternative road routes. Thes mpacts are discussed in detail in the Surface Access and Bulk Sampling EIS

SUMMARY

Development of a molybdenum mine is proposed at Quartz Hill, Alaska by U.S. Borax & Chemical Company (U.S. Borax). The site is located on the mainland, approximately 45 air miles east of Ketchikan. Current access to the site is by helicopter only and a temporary camp has been established to house workers.

Further exploration and development of the mine will require the construction of a temporary single-lane road to allow transport of large samples of ore to a pilot plant facility for conventional and SAG (semi-autogenous grinding) tests and development of the flotation flow sheet. If development of the mine proceeds, a two-lane, high standard highway will be needed to transport equipment, supplies, workers, and the ore concentrate. To minimize impacts and costs, it is desirable that both roads be constructed along the same alignment corridors.

Preliminary analyses have been completed for four alternative bulk sample road alignments and additional studies completed for three of the alignments. Two route alternatives, called the Keta and Blossom routes, are still under consideration for the mine road.

This report contains information, cost estimates, and conclusions based on review of existing studies, analyses, and designs, and a field reconnaissance of the Keta and Blossom routes.

Soil and rock conditions along either route corridor present difficult but not impossible engineering and construction problems. Other major road projects in southeast Alaska provide precedent for construction in similar terrain.

Construction of the bulk sample and the mine development roads is feasible along either the Keta or Blossom routes. For construction of the bulk sample road the cost estimates are $4.3 million for Keta and $5.2

same alignment corridor as the bulk sample road are $25.5 million for Keta and $21.5 for Blossom. Estimated yearly development road maintenance costs are $300,000 for the Keta route and $200,000 for the Blossom route, in 1981 dollars.

Regardless of which route is selected, the tailings pipelines are an important design factor. For maximum efficiency it would be desirable to complete the preliminary design for the pipelines and the mine development road before final layout and design of the bulk sample road.

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1.0 INTRODUCTION

The United States Borax & Chemical Company (U.S. Borax), on behalf of the Pacific Coast Molybdenum Company, desires to develop a molybdenum mine at Quartz Hill, Alaska. The site is located on the mainland, approximately 45 air miles east of Ketchikan. U.S. Borax has established a temporary camp at the site to house workers during the exploration phase of mine development. Access to the camp is by helicopter only.

Further exploration and development of the mine will require the construction of a temporary road to allow the transport of large samples of ore to a pilot facility. At the mill, large-scale tests will be run to confirm ore quality and to refine the milling process. The bulk sample road is planned to have a width of 14 feet. It will use temporary log bridges and culverts.

If development of the mine proceeds, a two-lane, all-weather road with high standard bridges and culverts will be required. To minimize impacts and costs, it is desirable that the bulk sampling and mine development roads be constructed along essentially the same alignment.

Preliminary analyses have been completed in the past by consultants to U.S. Borax for four alternative bulk sample road alignments. Three of these alignments originate on Wilson Arm and one starts from Boca de Quadra. Two of the Wilson Arm alternatives were rejected by U.S. Borax because of possible impacts to the Blossom River and costs of tunneling from upper Tunnel Creek to the mine (Sorenson et al. 1976).

Field reconnaissance, location, and comparative construction cost estimates have been completed for three of the alternative bulk sample road routes (Pool & Muench 1976). Also, preliminary ground survey lines have been established by Charles Pool & Associates for the two routes still under consideration (Keta and Blossom routes). Profile and cross-section data were obtained along these survey lines. Charles Pool & Associates has also prepared construction plans for approximately half of the

As noted, routing possibilities for the road alignments have been reduced to two basic corridors, one beginning at the head of Wilson Arm, the other at the head of Boca de Quadra. Each of these corridors was selected on the basis of extensive reconnaissance efforts by Mr. Eric Muench, a specialist in logging road routing in southeast Alaska. During the course of our review of these general route corridors, we examined the reports and field notes developed by Mr. Muench and others, reviewed other existing reports and data, examined stereo pairs of high quality color aerial photographs covering the alignments, discussed desirable roadway design parameters with representatives of U.S. Borax, and completed a field reconnaissance of both corridors. As a result of our review and reconnaissance efforts, we developed many specific ideas with respect to possible alternative alignments. These ideas were based on considerations of mitigating construction impacts, minimizing difficult and expensive elements of construction (such as major rock cuts, bridges, and snowshed structures), and providing increased safety for the roadway and the tailings pipelines. Each of our alternative ideas was checked by both aerial and on-the-ground reconnaissance. These studies convinced us that the two alignment corridors chosen do represent the best possible alignments in the two drainage systems. It is probable that detail revisions of the alignments will be needed when adequate cross-section data are in hand. However, the selected alignment corridors appear to be preferred choices for achieving mine-to-tidewater access.

This report presents the information and conclusions developed on the basis of our review and reconnaissance efforts and the preparation of preliminary construction cost estimates. The mine development road is emphasized. However, information pertaining to the bulk sample road is also presented.

Chapter 2.0 of this report contains a description of regional terrain, geology, and climate. Chapter 3.0 details our investigative procedure. A description of the two route alternatives is provided in Chapter 4.0. Traffic and design data are presented in Chapter 5.0, and a discussion of

2.0. REGIONAL DESCRIPTION

The project area is located on the mainland between Wilson Arm and Boca de Quadra in a roadless and remote part of the Tongass National Forest.

2.1 TERRAIN

The area consists of steep glaciated and snow-capped mountains with deep penetrating fjords. Approximately 20 percent of the area is lower than 1,000 feet in altitude and much of this is flatlands along rivers and deltas of major streams. The slopes rising from these flatlands are precipitous, reaching to heights of about 4,000 feet.

There are three rivers in the project area, the Blossom, the Wilson, and the Keta. All have headwaters in the Rousseau Mountain Range and flow approximately 20 miles before emptying into Wilson Arm or Boca de Quadra. River flow results mainly from direct precipitation and the melting of snow and glacial ice.

2.2 GEOLOGY

The project area, including both of the access corridors, is basically formed by granitic rocks of Mesozoic age. These rocks are a part of the Coast Range batholith, a major intrusive rock body that forms the mountainous terrain along the Alaska-British Columbia border. These rocks are usually hard, dense, and massive, although they do include occasional zones with a gneissic or schistose texture.

For several reasons, the rocks generally stand on steep to very steep slopes to substantial heights, primarily because of their high strength and generally massive occurrence. Another important factor is the nature of jointing (fracturing) of the rock. Such partings are usually widely spaced and tend to be thin, planar features without extensive crushed zones or gouge formation. Also, of course, glacial erosion in the region has removed the

and mechanical weathering. All these factors combine to produce a rock mass that is very strong and not commonly subject to large-scale slope failures.

Regional structural trends are expressed by two prominent joint and fault systems. One of these sets has a northwest-southeast trend, the other trends essentially north-south. Some of these features are very major, consisting of either faults or postulated faults with lengths in excess of 100 miles. It is believed that most of these structural features were created during the major period of folding, faulting, intrusion, and metamorphism at the end of the Mesozoic era (roughly 65 million years ago).

The current topography has been extensively shaped or modified by the erosion and deposition of continental and alpine glaciers during the Pleistocene epoch, which ended roughly 10,000 years ago, and by alpine glaciation during Holocene time. The most recent of the Pleistocene glaciations, the Wisconsin, stripped the bulk of the residual soil, weathered rock, and earlier glacial deposits from upland areas to leave broad areas of essentially bare, fresh rock. The glaciers deposited till and other drift in many areas, but usually as only a thin veneer. In a few places, notably in the lee of major uplands, in sharp indentions within the rock, and along the margins of major valleys, thick deposits of glacial drift have accumulated. Following retreat of the ice, normal processes of weathering and erosion resumed. This has modified the glacial terrain by the deposition of alluvium along the stream courses, down-cutting by the more major streams to form pronounced valleys or gouges, and formation of a thin soil profile (generally less than 2 feet thick, average) in those areas below the local timberline.

As a result of this geologic history and the youthfulness of the terrain, valley sides are often very steep. In fact, it is quite common for the slopes to be too steep for the soil that is forming on them to remain in place. This results in frequent, naturally occurring landslides that often take the form of debris avalanches or flows.

Most major streams flow in pre-existing bedrock valleys, but the specific location of tributary streams is often controlled by the joint

and fault patterns in the rock. Stream gradients are highly variable in response to the frequently "benched" topography of the valley sides. Abrupt changes from gentle or moderate gradients (say less than about 20 percent) to a precipitous gradient (about 90 percent to waterfalls) occur frequently. Major rivers continue to deposit substantial quantities of sediment into the fjords (near their mouths) to create extensive low-lying land areas. Typically at the mouth of major rivers there is a shallow tideflat area that terminates abruptly where the delta foreslope begins its descent to much deeper water. The rivers have braided or meandering channels in their lower reaches, typically for a distance of at least several miles.

As noted, the soil cover over rock in the project region is not well developed and is often quite thin. The soils seem to have formed partly as a result of weathering of a thin veneer of ablation till and the native rock, and partly by the accumulation of organic debris due to the growth, death, and decay of vegetation. The most common soil type in the project region appears to be a highly organic silty sand with varying contents of gravel, cobbles, and larger rock pieces. In general, these soils appear to be somewhat thicker in the more moderate slope areas. This is probably a result of downslope creep and other mass wasting processes moving the soils down from the steeper terrain segments.

In level to moderately sloping terrain areas, extensive muskeg deposits have accumulated. Muskegs are composed of various combinations of sphagnum peat, sedge peat, and muck. They are saturated with water throughout the year and range in thickness from less than 2 feet to more than 40 feet. Our observations suggest that their thickness does not normally exceed 10 or 12 feet maximum within the project region. Some thicker deposits may be present, however. Muskegs sometimes support a few trees but vegetation on them is usually limited to mosses, sedges, and low shrubs.

Previous road construction experience in this type of terrain has indicated that the surficial soils are highly susceptible to disturbance. This is expected in view of the high organic content of the soils and the fact that they are usually in a saturated condition. Any disturbance and/or

exposure to additional water (which is usually abundantly available) commonly leads to severe loss of strength or liquefaction.

The principal geotechnical factors that will influence road design and construction include the strength and stability of the rock, the thickness and stability of the residual soil, muskeg and glacial drift covering the rock, and the characteristics of foundation support and stream flow patterns at crossing points. Also, the nature of avalanche and snowslide hazards is very important for the Keta route but is of very limited importance for the Blossom route.

The project area is within the seismically active Circum-Pacific belt. There is a record of high seismic activity along two faults that lie to the west of the site and in the area to the west of these faults. However, the area east of these faults, including the project vicinity, has been relatively stable seismically. The trace of these faults is about 140 miles west of the site. Another feature that has been identified as a potential fault zone, the Clarence Strait lineament, lies about 55 to 60 miles west-southwest of the site. However, there are no known earthquakes associated with this lineament.

A preliminary seismicity evaluation suggests that the maximum earthquake acceleration in the project area would probably be due to one of two possible events. These include: (1) a Magnitude 8+ shock at the nearest point of the Queen Charlotte fault about 140 miles from the site or (2) a Magnitude 6.5 event on the Clarence Strait lineament about 55 miles from the site. This assumed event is equivalent to the largest known shock that has occurred in the vicinity of the lineament. We have not completed a rigorous analysis, but, interpolating from previous analyses for projects in this general region (Dames & Moore 1972), we estimate that the maximum earthquake-related lateral acceleration expected in the project area would be on the order of 0.10 g. This lateral acceleration value would apply to roadway embankments, cut slopes, and relatively small bridges. We emphasize that this recommendation may not apply to such structures as tailings dams, water supply dams, or major bridges (spanning more than 200 feet). More detailed and specific

2.3 CLIMATE

The project area is within the coastal maritime climatic zone. This zone is typified by cool summers, mild winters, and heavy precipitation. The Pacific Ocean is the dominant climatic factor in the region. It serves to moderate temperatures and keeps moisture levels high. Topography and elevation also have profound effects on both temperature and precipitation. Weather data have been gathered near the mine site and at several other locations within the project region since 1978. However, this length of record is not sufficient for confident predictions of weather information along the roadway alignment.

Normal annual precipitation in the region is in the range of 100 to 150 inches with October and November usually the wettest months. At sea level much of the precipitation is in the form of rain with snow accumulations greater than 1 foot relatively infrequent and of limited duration. However, at higher elevations very large accumulations of snow are common. The average annual snowfall at Quartz Hill is reported to be approximately 800 inches. Our observations suggest that the snow pack does not melt off at higher elevations (say above 1,000 feet) until the month of May. Temperatures below 0 or above 90 degrees (Fahrenheit) are extremely unusual in the region.

3.0 INVESTIGATIVE PROCEDURE

Our investigation of access routes began with collection and review of previous reports, analyses, and designs. Individuals who were familiar with the routes and who had been involved in the route locations were interviewed.

On-the-ground field reconnaissance of the routes was made during a 10-day period from May 10 to May 20, 1981, working out of the Quartz Hill exploration camp. The route alternatives were inspected from the air by helicopter several times. Much of both routes, including all of the most difficult construction areas and all major structure locations, was inspected on the ground. Oblique aerial photos and ground photos were taken as the reconnaissance progressed and were used later for study purposes in developing preliminary cost estimates and our conclusions.

It is important to remember that our investigation of the access road routes was done at a reconnaissance level at a time when good topographic information was still under development and before controlling design parameters were firmly established. Our conclusions are generally and conceptually correct but further study will be required for specific route selection within the corridors and for final design.

Our cost estimates have been developed on the basis of approximate estimates of the quantities of various materials that will be needed. This is particularly true of quantities of excavation and fill which will, of course, depend very heavily on the specific alignment chosen. We believe that the unit price information used in the estimates is quite good, particularly because of the small range in the estimates that the use of different techniques provided. We have been very careful to apply the same care and reasoning to our quantity estimates on both routes. Therefore, percentage difference in costs for the two corridors are not expected to change significantly. Significant differences in the absolute cost of constructing either alignment are possible, however, depending on the actual quantities

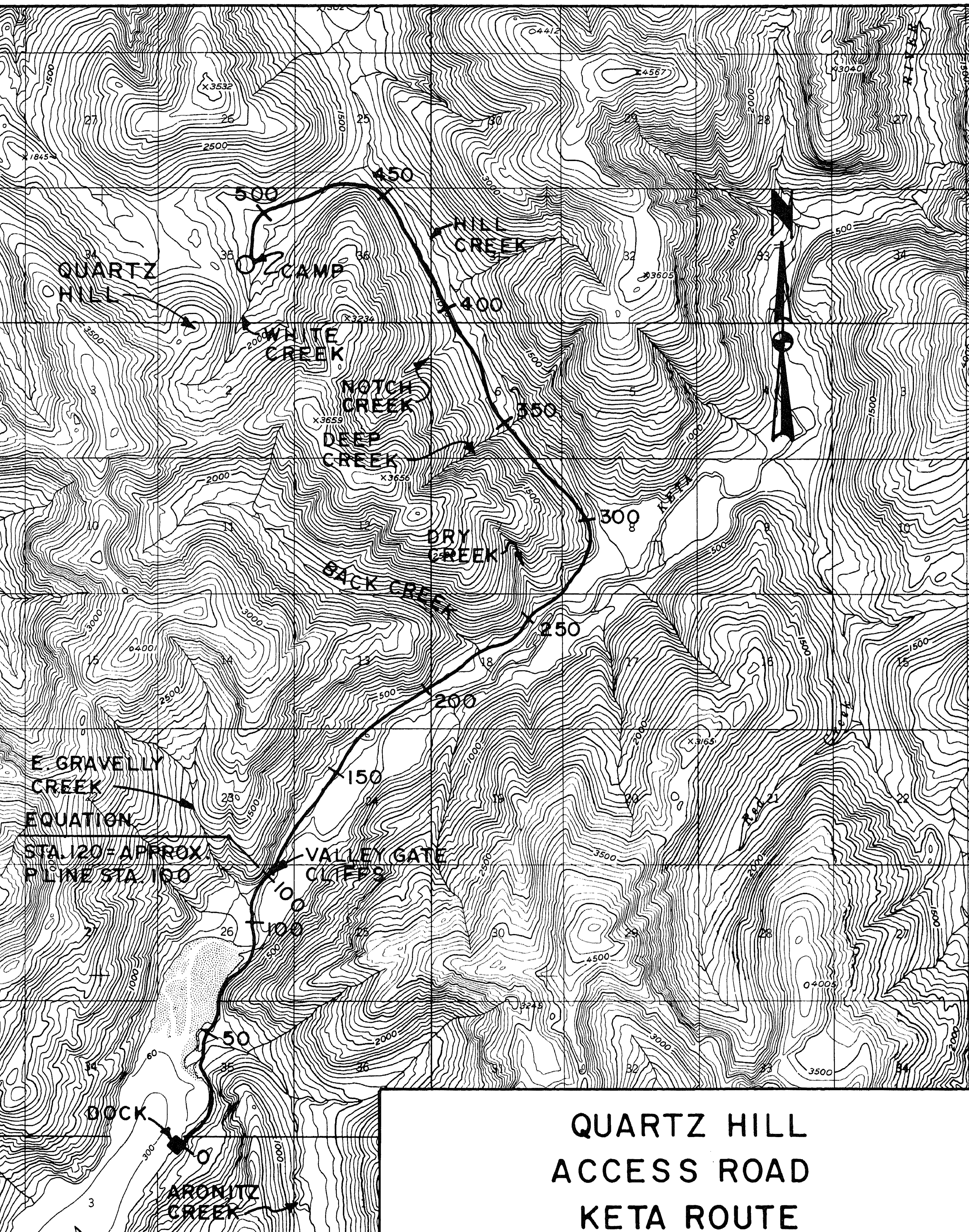
Topographic mapping that was available and used during the investigations included the 1955 U.S.G.S. topographic quadrangle, Ketchikan (B-2), Alaska, with a scale of 1 inch equal to a mile. In addition, mapping prepared by Charles Pool & Associates, Inc., Ketchikan, Alaska, 15 November 1976, with a scale of 1 inch equal to 1,000 feet was used.

4.0 DESCRIPTION OF ALTERNATIVES STUDIED

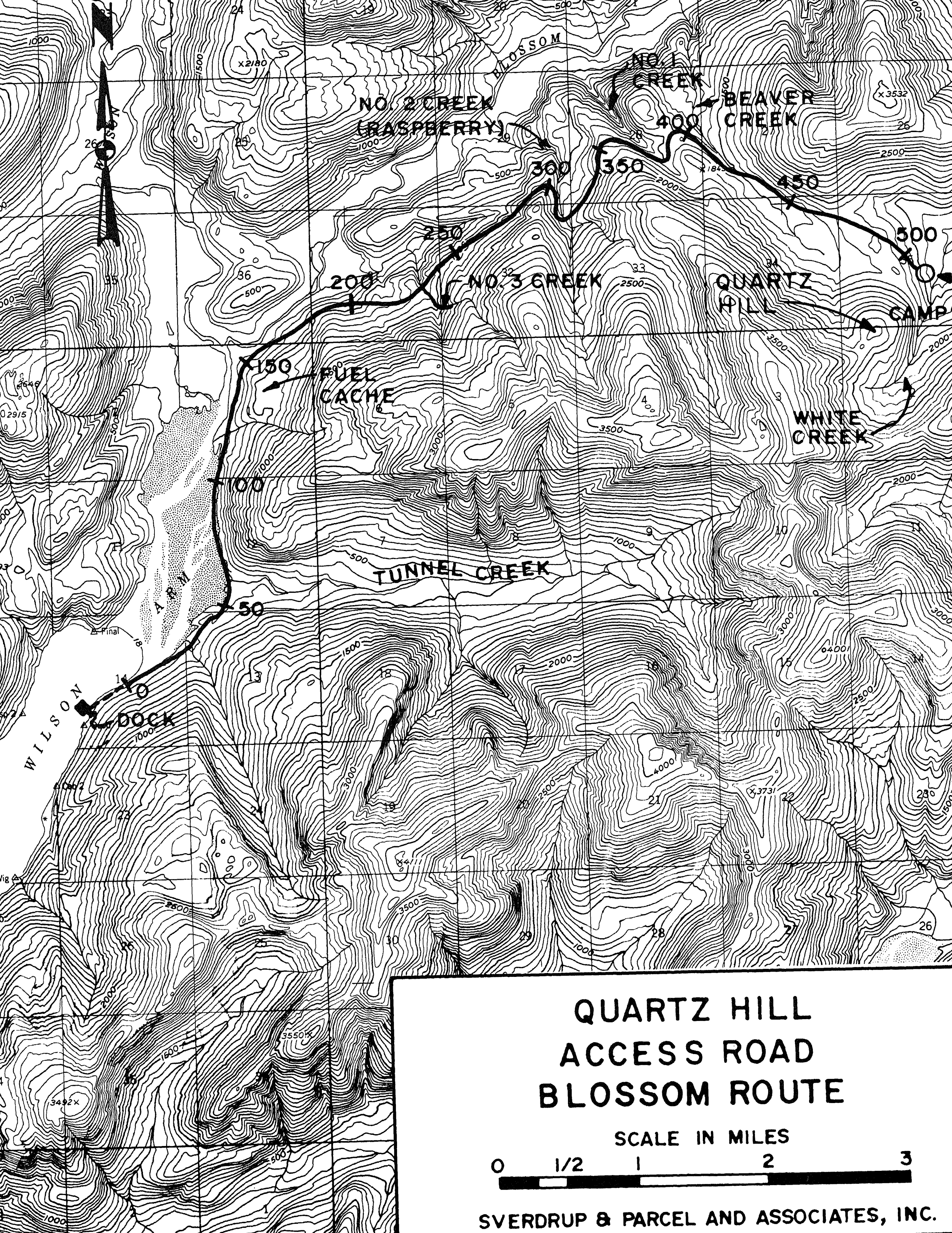
The two alternative access routes that were studied are designated the Keta and the Blossom routes. The Keta route originates near the head of Boca de Quadra Inlet, and the Blossom route originates near the head of Wilson Arm. The approximate locations of these routes are shown on Figures 1 and 2 and Plates A and B.

U.S. Borax has provided general geometric criteria for the mine development road. These criteria are based on general industry experience with respect to the safe and efficient operation of this type of roadway. A typical development road cross-section has been adapted with slight modification from one developed by other engineering studies and provided to us by U.S. Borax. This section is shown on Figure 3. The section shows a two-lane road with the tailings pipeline placed at the base of the cut slope. However, there are many locations along both routes where the pipelines must be protected from rockfalls or landslides. In such areas the toe of the cut slope should be reserved for a debris and rockfall ditch and the pipelines will need to be buried, relocated, or protected in some other manner. There will also be areas where the pipeline will need to be buried or otherwise protected from avalanches. Also, of course, the pipelines should not be susceptible to damage by snow removal equipment. One possible alternative pipeline placement would consist of "stacking" the lines one above the other adjacent to cut slopes to facilitate construction of a roof to protect them from rockfalls and/or to decrease the total section width required. Other possible alternatives would include burying the lines in fill areas (to decrease the total top width and therefore the total volume of the fill), suspending the lines beneath bridges or half bridge structures, or placing the lines in either a side-by-side or stacked configuration on the outside of the roadway.

U.S. Borax has indicated that the pipelines must be accessible for repair and replacement since the tailings slurry is abrasive and the lines will wear out with time. Two lines are required to allow one line to be out



QUARTZ HILL
ACCESS ROAD
KETA ROUTE
QUARTZ HILL
CAMP
WHITE CREEK
HILL CREEK
NOTCH CREEK
DEEP CREEK
DRY CREEK
BACK CREEK
E. GRAVELLY CREEK
EQUATION
STA. 120 = APPROX.
P LINE STA. 100
VALLEY GATE CLIFFS
DOCK
ARONITZ CREEK
KETA
0
50
100
100
150
200
250
300
350
400
450
500

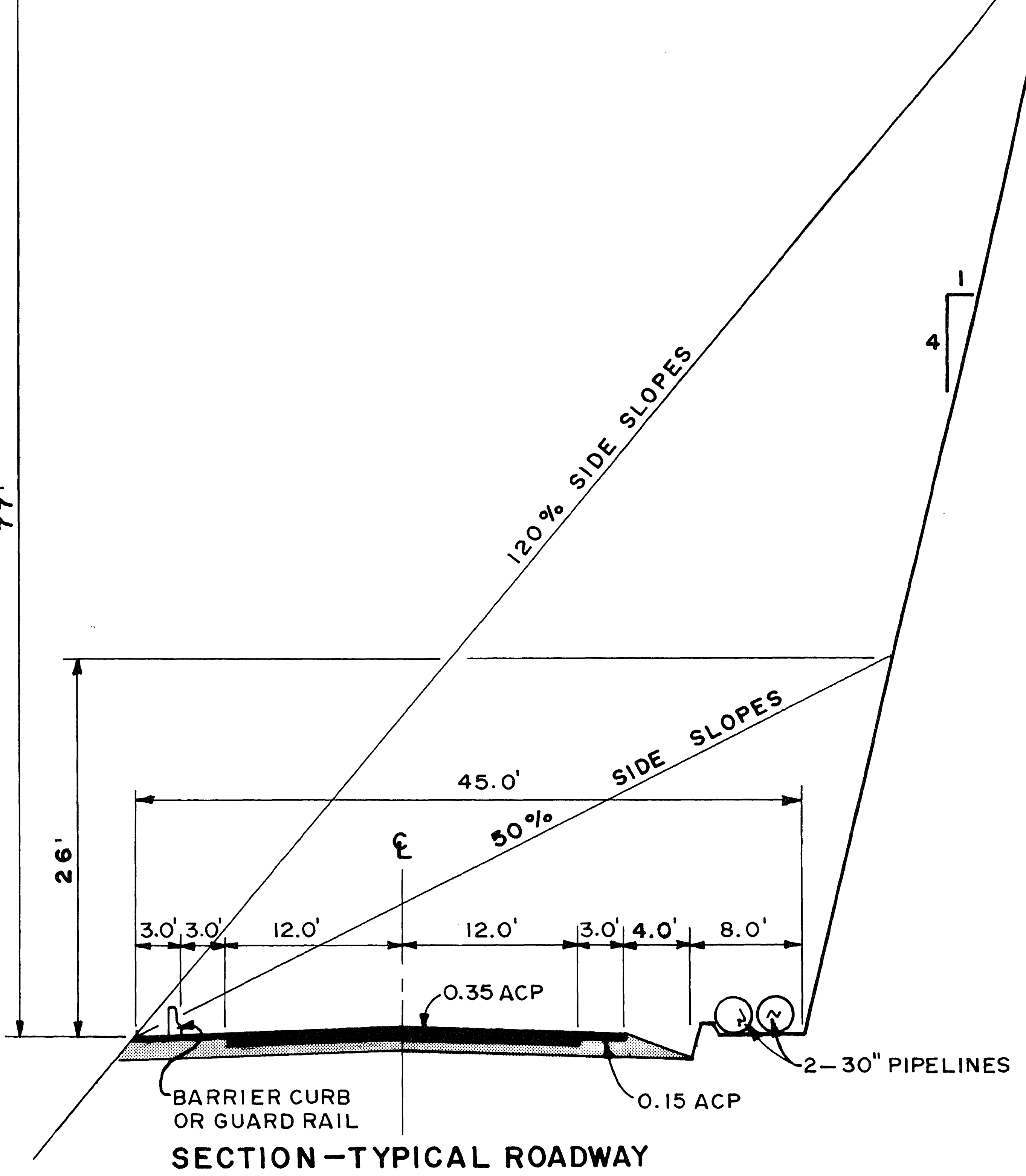


QUARTZ HILL ACCESS ROAD BLOSSOM ROUTE

SCALE IN MILES

0 1/2 1 2 3

SVERDRUP & PARCEL AND ASSOCIATES, INC.



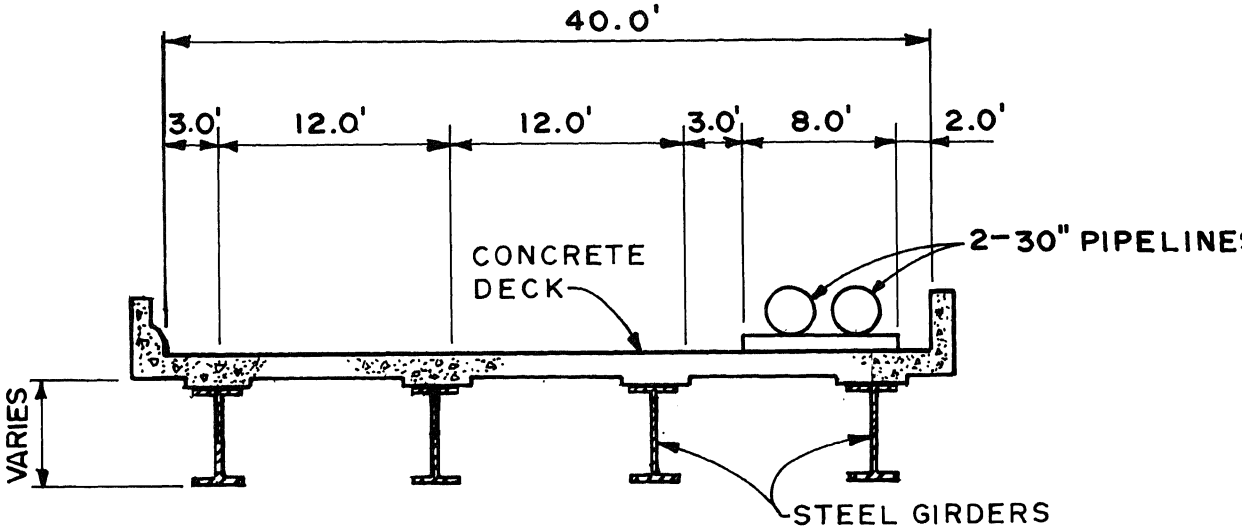
SECTION—TYPICAL ROADWAY

QUARTZ HILL PROJECT
PROPOSED
MINE DEVELOPMENT ROA

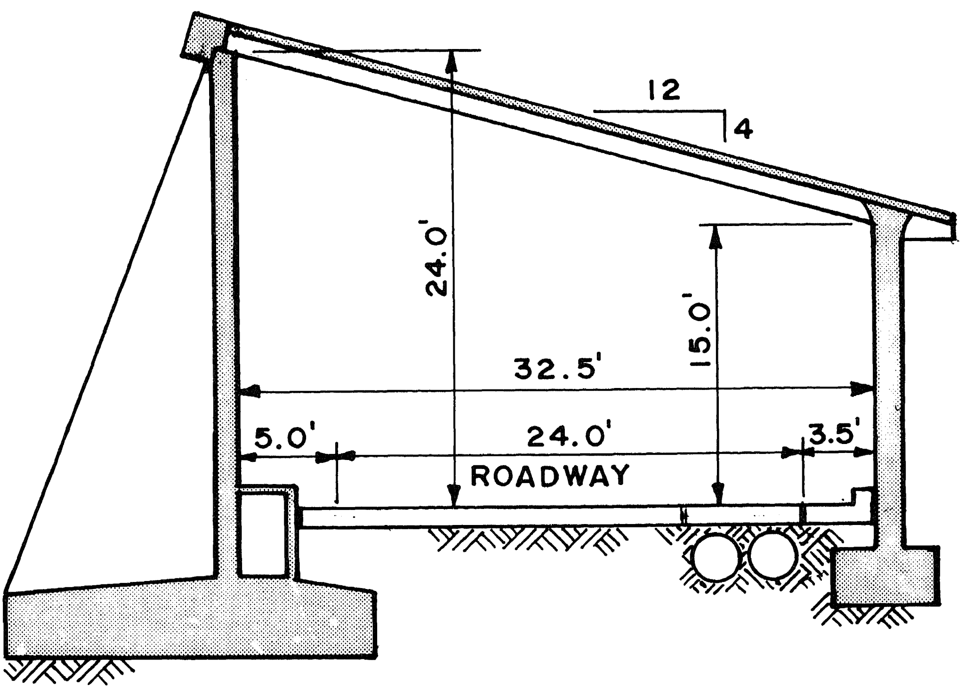
U.S. Borax has also suggested that a design speed of 35 miles per hour is preferred for efficient roadway operation. Based on our discussions, we understand that U.S. Borax elected this speed as a "reasonable" one both with respect to their operations and the nature of the terrain that the mine development road must traverse. Apparently higher design speeds would be desirable but would be expected to impose unacceptable costs and construction difficulties. Conversely, somewhat lower design speeds may be acceptable to U.S. Borax if detailed geometric design studies indicate that the 35 miles per hour design speed would be too difficult and/or costly to achieve.

According to U.S. Borax, it is highly desirable that the tailings pipelines be supported above grade and on the roadway prism as much as possible. This location is preferred both for ease of access for repair and replacement and because spill control measures can be relatively easily provided. U.S. Borax has indicated, however, that occasional deviations from this pipe location procedure may be acceptable if accommodating the pipelines on the road would lead to severe cost and/or practicality problems. For example, cut-and-fill quantities may be reduced if the tailings lines can contour around a hill or be supported on a short segment of trestle to maintain their required continuously falling grade while the mine development road "rolls" over the terrain to a degree. This issue should be addressed during final design when good topographic information is available so that quantities and costs can be estimated more precisely.

The typical bridge section shown on Figure 4 illustrates a steel girder structure with a precast, reinforced concrete deck. Cast-in-place concrete will be required between precast sections for slab continuity and attachment of the girders. During design development, consideration should be given to locating the pipelines under the bridge, between the girders, to minimize structure costs. A typical snowshed section is also shown on Figure 4. Construction will be cast-in-place concrete for the retaining wall, footings, and columns. The roof girders will be precast,



SECTION-TYPICAL BRIDGE STRUCTURE



SECTION-TYPICAL SNOWSHED STRUCTURE

QUARTZ HILL PROJECT

TYPICAL STRUCTURE SECTION
MINE DEVELOPMENT ROA

In places, some savings may be achieved with a "bridge half structure" in combination with relatively limited rock excavation. Our preliminary cost analysis suggests that this approach may become economically viable as rock excavation depths exceed about 250 feet. A typical section of a bridge half structure is shown on Figure 5. Decisions as to the real usefulness of this design approach must await the final design process when good topographic information is available.

4.1 KETA ROUTE[1]

This road alternative would begin at a wharf site on the southeast side of the Boca de Quadra near its head and would run up the Keta River valley for nearly 5 miles, crossing the river once. It would then ascend the steep northern side of the valley as it "turns the corner" into the Hill Creek valley. The line would continue along the southwestern side of Hill Creek for about 4 miles and would then follow the White Creek valley in a west and southwest direction to the mine site. Most of the Keta River segment would traverse alluvial valley fill deposits; however, in some places rock excavation would be required to bench the road into the hillside. Where the road ascends from the Keta River floodplain into the valley of Hill Creek, substantial rock excavation in very steep to precipitous terrain would be required. Most of the Hill Creek segment of the alignment involves construction on moderate to occasionally steep side slopes but in this area there are a number of significant avalanche tracks and stream crossings (some of them the same). These circumstances are a very important factor in design, construction, and operation of the roadway. The White Creek segment of the Keta River route traverses moderately to gently sloping terrain with significant muskeg areas. A more detailed geotechnical description of this route is presented in subsequent paragraphs.

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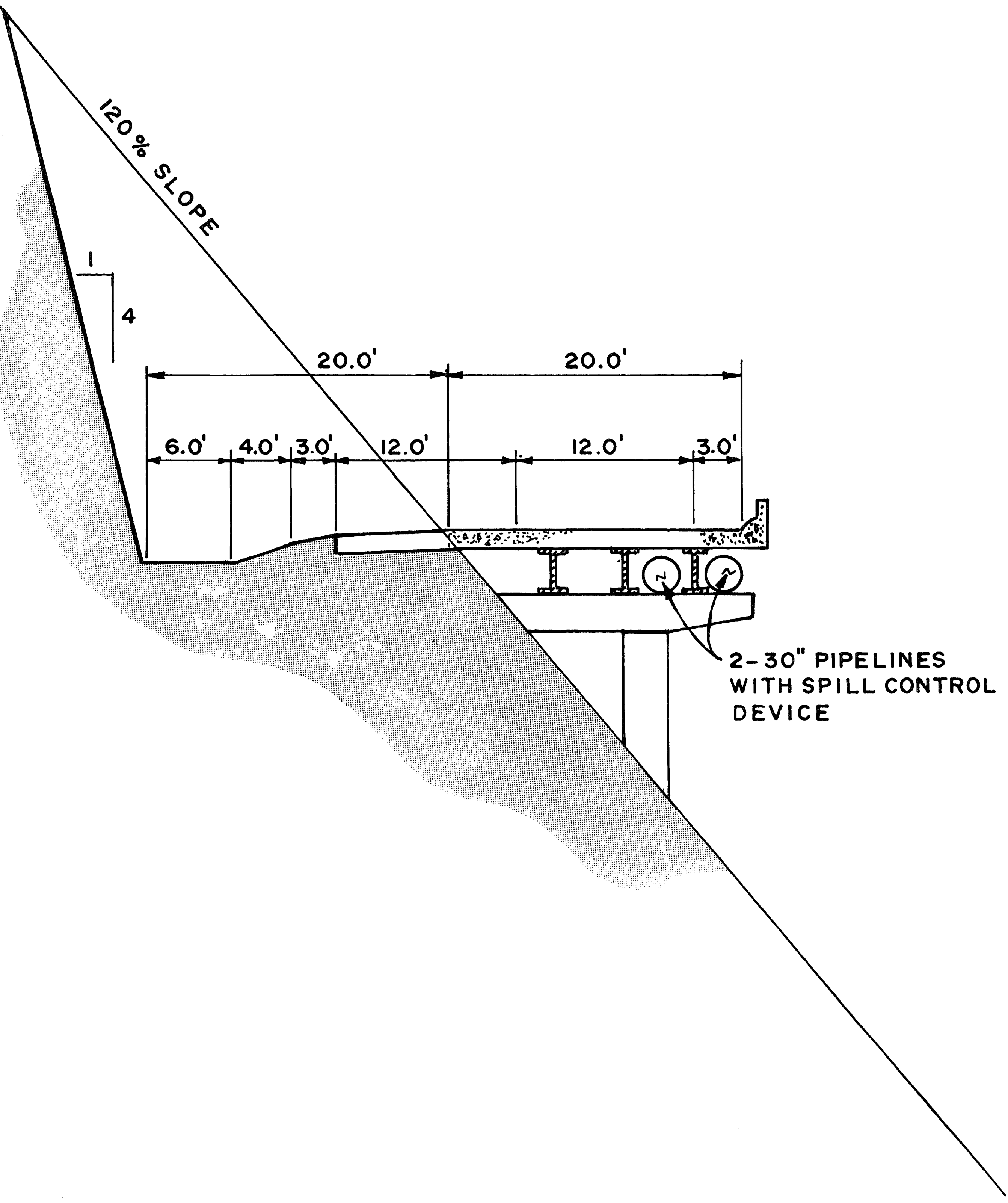
(1) Please note that this route is somewhat different from that described in



QUARTZ HILL PROJECT

4.1.1 Wharf to Valley Gate Cliffs Segment

In this approximately 2-1/2-mile segment the alignment lies along the steep, rocky shoreline of the fjord for several thousand feet, crosses the broad lower valley of Aronitz Creek, and then traverses the tidelands area of the southeastern valley margin to the point where the Keta River impinges against the valley wall. The alignment then crosses the Keta River and proceeds across the floodplain of the river and tributary creeks to the "Valley Gate" cliffs. This is an area where the river lies against the northwestern side of the valley. Up to about 3,000 feet of road will need to be benched into the rock, perhaps full-bench type construction, in the area near the wharf and at the southern end of the Valley Gate Cliff area. Both the Aronitz Creek and Keta River crossings appear to be good bridge sites, with generally stable channels. The Keta River crossing is well confined by rock cliffs on the southeastern bank and an elevated moraine area on the northwest. This moraine, incidentally, is responsible for diverting the river against the southeast side of the valley at this point. Both the tidelands area and the floodplain, where an embankment will be constructed, provide good foundation conditions for embankment construction. The soils appear granular; there is no evidence of any material that would lead to slope failures or unusual amounts of settlement.

Both the Keta River and Aronitz Creek bridges will require pile support. This should be routine construction but coarse alluvium is expected. Steel H piles of heavy section, with suitable tip reinforcement, are recommended.

4.1.2 Valley Gate Cliffs to Dry Creek Area

Throughout most of this roughly 3-1/4-mile segment, the alignment traverses the floodplain of the Keta River. There is one short segment where the river flows against the steep rock bank where excavation, perhaps full-bench type construction, will be needed for several hundred feet. At another point, the alignment will leave the floodplain and traverse upland terrain for roughly 1,000 feet as it passes through a lower terrain area

behind a rock knob that extends into the northwestern portion of the valley. The alignment also crosses a substantial tributary, Back Creek, which emerges from the general valley wall in a precipitous area and has a somewhat unstable channel where it crosses the floodplain. Because the alluvial valley fill deposits throughout this segment appear to consist of generally granular material, problems of embankment stability or unusual settlement would be expected. The upland area is basically rock supported with a relatively thin soil cover.

The major challenge in this segment will be development of a safe, stable crossing of Back Creek. It is apparent that occasional debris floods of significant magnitude emerge from the rock valley of the creek. Apparently, these masses of debris sometimes clog whatever channel exists at the time and divert the creek into one or two new channels. Many old channels can be seen in the vicinity of the present creek. It might be possible to cross the stream with a relatively high bridge located close to the steep rock valley wall. However, reliable information is lacking with respect to the height of debris floods. The configuration of the canyon and the debris that can be seen just below the mouth of the canyon suggest that very substantial floods sometimes occur. Therefore, it appears that a safer approach (and one less difficult to accommodate within the general roadway grade requirements) would be to cross Back Creek at a point at least several hundred feet below the rock canyon mouth. "Training dikes" protected by heavy riprap will be needed. These dikes, together with the roadway embankment, will form a sort of "stilling basin" which can collect the debris and allow the water to pass beneath the bridge. Obviously, maintenance work to remove accumulated debris will be required following significant floods.

The Back Creek bridge should be pile supported. This is expected to be routine construction although some difficulty may be encountered in achieving adequate pile penetrations into the expected coarse alluvium. Piles that can withstand hard driving in this type of soil, such as heavy H sections with suitable tip reinforcement, are recommended.

4.1.3 Dry Creek Into Hill Creek Valley Segment

This segment has a length of roughly 1 mile and in that distance the road alignment ascends from the Keta River floodplain into the Hill Creek valley. In so doing, it wraps around the nose of a steep to precipitous rock ridge. A substantial portion of this interval will require full or partial rock bench construction. As is typical of the region, the rock consists almost entirely of intrusive igneous material, probably of generally dioritic composition. Some exposures of more schistose material were noted in this segment but the quality of the exposures did not permit detailed mapping of their extent in the available time. The occurrence of this rock type is not significant to the roadway project.

In general, the rock is expected to be stable in very steep cut slopes. The construction process is likely to contribute to the formation of some small-scale, shallow landslides of the soil off the rock. This will probably occur both above and below the alignment, but we expect that most such episodes will be on the downhill side.

4.1.4 Hill Creek Segment

In this segment, the alignment lies along the southwestern side of the Hill Creek valley. A distance of roughly 3 miles is involved. Three significant bridges (or major fill/snowshed structures) will be required to cross Notch Creek, Deep Creek, and Bench Creek. With respect to bridge foundation considerations, all of these crossings are favorable. Hard, strong stable rock occurs at shallow depth on both sides of each of these valleys. Notch Creek and Bench Creek can both be bridged using conventional kinds of structures supported on the rock. Depending on the specific location of the alignment at the Bench Creek crossing, it may be feasible to use a large culvert and fill. Deep Creek could also be bridged, although a rather long span would be required. However, the avalanche circumstances here appear to render a bridge unfeasible (D. Hamre, Alcan Snow Management Services, 1981, personal communication). There is no geotechnical reason

constructed across the Deep Creek valley. For stability considerations, the side slopes of such a fill should probably be sloped on the order of 3 to 1 (horizontal to vertical). The upstream slope may need to be flatter, perhaps on the order of 4 to 1, based on considerations of avalanche flowage. Avalanches would be brought down with an avalanche control program and either flow through the culverts or over the roadway. The avalanche safe method is to construct snowsheds.

Aside from the stream crossings, most of this segment will involve sidehill construction on sideslopes in the 30 to 50 percent range (mostly 40 percent or less). Avalanche defense berms, mounds, and catchment areas will probably be needed at a number of localities (D. Hamre, Alacan Snow Management Services, 1981, personal communication) but otherwise routine road construction is anticipated. We estimate that about 2 to 6 feet of soil covers diorite bedrock throughout much of this segment. The soil is probably thicker in major avalanche runout areas, however, perhaps up to 15 to 20 feet. Several small cross-drainages will require culverts. Few landslide problems are anticipated in this area. Those that do occur are most likely to be below the roadway and will result from spillage of excavated material.

4.1.5 White Creek Segment to Mine

This last segment of the alignment has a length of approximately 1 mile. The line lies entirely within the White Creek valley and includes a crossing of the stream. The route will traverse gently sloping to moderately sloping terrain (estimated side slopes in the 0 to 40 percent range with most less than 30 percent). A substantial portion of the route will traverse muskeg areas where significant embankment fill will probably be needed to establish a stable grade. The White Creek crossing is at a stable channel reach with strong, dense bedrock exposed in the channel bottom a few feet below the ground surface. A bridge can be supported on piers or abutment walls founded on the rock. There appears to be very little potential for construction-generated landslides or other geotechnical problems in this

The Keta route is 10.1 miles long and climbs to a maximum elevation of 1,400 feet. A listing of the Keta route structures is contained in Table 1.

4.2 BLOSSOM ROUTE

This road alternative begins at a wharf site on the southeast side of Wilson Arm near its head and runs along the eastern side of the arm and the Wilson/Blossom River tidelands for almost 3 miles. It then gradually ascends the steep eastern side of the Blossom River canyon, crossing the valleys of several significant tributary creeks, to enter the upper valley of Beaver Creek about 7-1/2 to 8 miles from the wharf. The line then continues southwestward following the valley of Beaver Creek for approximately 2 additional miles to the mine site. The segment along Wilson Arm and the river tidelands involve several portions, totaling roughly several thousand feet, of full or partial rock bench construction along the shoreline. The remainder of this segment would be constructed by building an embankment along the edge of the tidelands or across the floodplains of tributary creeks.

The "side hill" segment where the line ascends from the tidelands to the Beaver Creek valley involves very substantial portions (most of the segment) where construction on steep to precipitous side slopes and cliffs will be required. The soil cover over rock is quite thin throughout most of this area.

The Beaver Creek portion of the alignment traverses moderately to gently sloping terrain and includes significant muskeg areas.

There are a very few, minor snowslide or avalanche-susceptible areas along the Blossom route. A number of bridges will be needed to cross tributaries to the Blossom River. A more detailed geotechnical description of the Blossom route is presented in subsequent paragraphs.

TABLE 1

KETA ROUTE STRUCTURES
MINE DEVELOPMENT ROAD

Approximate Station	Feature	Approximate length (feet)
38	Aronitz Creek	120
89	Keta River	200
105	East Gravelly Creek	Large culverts
110	Valley Gate Cliffs	400 (half structure)
117	Gertsley Creek	Large culvert
139	Brushy Creek	Large culverts
218	Back Creek	100 plus riprap
250	Dry Creek	40
280	King Arthur Gulch	50
296	Bench Creek	80
327	Avalanche Chute and Creek	Embankment and large culverts or 300-foot snowshed
345	Deep Creek and Avalanche Chute	Embankment and large culverts or 500-foot snowshed
386	Notch Creek	60
474	White Creek	70
502	Creek	Large culvert

4.2.1 Wharf and Tidelands Segment

This segment has a length of slightly over 2 miles. Some rock excavation, roughly 2,000 to 2,500 feet, will be needed near the planned wharf area to accommodate the roadway. Two significant streams are crossed, Tunnel Creek (two branches) and a somewhat smaller unnamed creek flowing into the tideland area between Tunnel Creek and the wharf site. Conventional bridge construction will be involved. Pile support is appropriate for the bridges and because of the strong possibility of coarse alluvium, including boulders, strong H section piles with appropriate tip reinforcement would be in order. Dikes protected by riprap, as well as some riprapping of the embankment, appear appropriate at the Tunnel Creek floodplain crossing to mitigate potential channel changes during high flow conditions. Roughly 1 mile of this segment will involve embankment construction at the edge of the tideflats area. The tideflat sediments appear to consist dominantly of sand and gravel. No problems are anticipated with embankment failure or unusual settlement.

This segment involves generally routine construction. The most significant issues will be the diking and embankment protection to protect both Tunnel Creek crossings and the unnamed creek crossing.

4.2.2 Side Hill Segment

This segment extends from the point where the alignment leaves the Wilson Arm tideflats area along the steep to very steep southeastern side of the Blossom River valley (and tributary valleys) to the crossing of No. 1 Creek, a distance of approximately 5 miles. There are a number of places along this segment where the alignment will probably be located on near-level or gently sloping benches where routine embankment construction or excavation will be needed. A precise estimate of the amount of this type of terrain within the segment must await completion of cross-sectioning and map preparation, as well as specific choice of alignment and grade. Small differences in either grade or alignment can change the amount of "easy" terrain in this

segment) consists of steep to precipitous cross slopes, including many rock cliff areas. There are crossings of No. 1 Creek, No. 2 Creek (Raspberry Creek), No. 3 Creek, an unnamed creek that discharges onto the tidelands near the start of this segment, and a number of other small streams. Only the unnamed stream near the start of the segment shows evidence of torrential flows or debris floods in the vicinity of the crossing point. These conditions probably do not occur on the other streams because the crossing points are well up on the hillside where there is no pronounced break in gradient and where the streams generally occupy well defined channels. There are no particular foundation problems for bridges at any of the stream crossings. Conventional piers or footings supported on rock appear to be available at shallow depth. The unnamed stream mentioned above is a possible exception, depending on the specific location of the crossing point. If piles are required here, coarse to very coarse alluvium, and perhaps no more than 10 to 15 feet of it over rock, should be expected. Heavy steel H section piles with suitable tip reinforcement would be in order.

In the bench areas mentioned previously, soil conditions probably consist of up to several feet of soil or muskeg overlying rock. In places the muskeg thickness may be as great as 6 to 8 feet. In the steeply sloping terrain areas the usual conditions are a few inches to perhaps several feet of soil overlying rock. As noted, there are many bare rock areas. There are also a few places where small quantities of talus have accumulated. In general, we do not expect any of the talus deposits to exceed a thickness of about 10 feet over rock (as a maximum). Most are probably thinner. Talus deposits occur in only a few places, a very small percentage of this alignment segment.

An exception to these general soil conditions may occur along the south side of the No. 1 Creek valley near the planned crossing point. Good exposures were lacking but those that were available, in combination with the terrain configuration, suggest that glacial drift deposits may occur here for perhaps 300 to 600 feet of the alignment. If such deposits are present they could be as much as 15 to 20 feet thick.

Obviously, the precipitous sections of the alignment will require full or partial rock bench construction. Steep terrain areas will probably require some rock excavation together with rock fill placement to form the roadway. Through cuts are possible in several areas, depending on the specific alignment chosen. Virtually all of the excavated rock should be usable for embankment construction. Excavated soil will need to be wasted. It is inevitable that the construction will lead to a number of shallow landslides, most of them probably occurring below the roadway alignment, as a result of waste material or fill spilled over the edge. Because of the steep terrain, this sort of spillage cannot be completely avoided, even with the exercise of great care. Throughout most of this segment any such slides will not directly enter the Blossom River or its larger tributaries. However, in the few instances where the alignment is in close proximity to the tributary creeks, and especially where it traverses the sides of the tributary valleys close to stream level, slides will probably reach the streams. These problems and their impacts can be minimized by very careful attention to construction operations, including blasting, and scheduling of work so that any turbidity problems occur at relatively noncritical times. In some places, temporary silt barriers or siltation ponds may possibly be incorporated to mitigate any water pollution effects.

All of the very numerous rock exposures throughout this segment reveal hard, dense granitic material, typically either diorite, quartz diorite, or gneiss of similar composition. Exposures are generally massive with relatively few joint planes and no evidence of extensive crushing or the development of gouge zones along any fractures in the rock. It is also very apparent that glacial action has removed whatever surface zone of broken and weathered rock may have existed. (In places broad grooves carved by the flowing ice mass can still be seen on the valley side.) Because of the dense, massive nature of the rock and the general absence of significant quantities of a weathered surface zone on the rock, we conclude that this area should be "stable" with respect to large-scale slides or rockfalls. Our ground and aerial reconnaissance did not disclose evidence of any such rockfall or major slide in post-glacial time. The only talus accumulations

erosion rather than any catastrophic event. Many small-scale slides of soil over rock are probable in this area, as described above.

4.2.3 Beaver Creek Segment

This segment extends from the crossing of No. 1 Creek across a saddle in the low ridge separating the No. 1 Creek and Beaver Creek drainages and continues along the valley of Beaver Creek to the mine site. The total distance is about 2 miles or slightly more. Most of the terrain along this segment is near level or gently to moderately sloping hillsides. Much of it, probably about 60 to 70 percent, is characterized by muskeg deposits which could be moderately thick in some places. The alignment crosses Beaver Creek at a narrow reach of the valley just downstream from an extensive meadow complex containing some beaver ponds.

The shape of the terrain and a few poor exposures suggest that glacial drift deposits may occur in some places. In general, we expect the soils to consist of muskeg deposits up to perhaps 10 to 15 feet thick (but usually thinner) overlying thin glacial drift deposits and/or bedrock. However, on the southwest side of the Beaver Creek valley at and just downstream from the intended crossing point, the terrain configuration suggests that thick glacial drift deposits may occur. Significant excavation will probably be required in this area to maintain grade and, if this is true, the cut may generate significant quantities of waste. Depending on its composition and moisture content, as well as the weather during construction, the glacial drift material may not be usable as embankment fill. Much of this segment will require embankment fill construction with some areas of partial sidehill cut probable. Depending on the grade chosen, a Beaver Creek bridge may be supported on footings or piers or it may require pile support. In either event, no unusual design or construction problems are anticipated.

The Blossom route is about 10 miles long and climbs to a maximum elevation of 1,800 feet. A listing of the Blossom route structures is contained in Table 2.

TABLE 2

BLOSSOM ROUTE STRUCTURES
MINE DEVELOPMENT ROAD

Approximate Station	Feature	Approximate length (feet)
22	Creek	40
58	Tunnel Creek	60 plus riprap
61	Tunnel Creek	80 plus riprap
123	Creek	60
202	Creek	Large culverts
205	Creek	Large culverts
231	No. 3 Creek	60
258	Creek and V Notch	50
309	No. 2 Creek (Raspberry)	120 (skewed)
384	Creek and V Notch	40
390	No. 1 Creek	Large culverts
425	Beaver Creek	Large culverts

5.0 TRAFFIC AND DESIGN DATA

Estimates of average daily traffic (ADT) for the bulk sample road have not been developed. However, a low traffic volume, composed mostly of heavy vehicles, is expected.

Informal estimates by U.S. Borax suggest an ADT for the mine development road of up to about 500 vehicles maximum. The actual volume will depend on whether a townsite or campsite is developed, its location, and the nature of its connection to the mine road. This will also determine the mix of vehicle types. Present planning does not anticipate the use of this road by very heavy mine vehicles (large off-highway trucks).

5.1 BULK SAMPLE ROAD

The bulk sample road is planned to be a single lane with a width of 14 feet and with vehicle turnouts spaced along the alignment at feasible locations. No specific design speed or geometric standards have been established for this road, except that it should generally follow the alignment of the mine development road to minimize impacts and provide access for construction of the development road.

5.2 MINE DEVELOPMENT ROAD

The mine development road will be a two-lane paved facility constructed to highway standards, and including high standard bridges and culverts. A typical section of the road is shown on Figure 3.

U.S. Borax has indicated that the desired design speed for the road is to be the highest that can be obtained at a reasonable cost, up to 35 miles per hour. Table 3 is a listing of typical highway geometric design standards.

TABLE 3

GEOMETRIC DESIGN STANDARDS
MAIN HIGHWAYS

	Design Speed (mph)	
	30	40
Radius	230 feet	430 feet
Gradient (maximum)	9 percent	8 percent
Sight Distance	200 feet	275 feet

Source: AASHTO 1965.

6.0 IMPORTANT DESIGN FACTORS

There are several important design factors that must be considered during design development of the mine road.

6.1 TAILINGS PIPELINE

Although occasional deviations are possible for short distances, the tailings pipelines must generally follow the mine development road so that they are accessible for repair and to make it easier to control any potential tailings spills. Therefore, in an overall sense, the grade of the tailings pipelines will control the profile grade of the mine development road. Since the pipelines require a continuously falling grade to prevent solids deposition in the line, the option of "rolling" the road alignment over adverse topography is inherently limited. This limitation will probably increase the cost of the road.

Within the above limitation there is some flexibility on a localized basis regarding design and position of the road versus the pipeline. This flexibility should be used to best advantage to reduce cost and minimize environmental impact. As previously discussed, many design techniques are available to separate the tailings pipelines from the road grade. These include such things as sinking the pipelines below road grade in a relatively narrow trench to minimize rock excavation, hanging the pipelines beneath bridges to minimize structure width, carrying the pipelines on short trestle segments to minimize fill quantities across swale areas, and routing the pipelines along a narrow grade constructed specifically for that purpose around the contour of a hill so that major through cuts can be minimized. The applicability of these techniques, as well as their specific location and extent, must await the final design process when good topographic information is available.

We believe that maximum efficiency in the overall road/pipeline project would be achieved if the preliminary design of the pipelines was completed,

and their design parameters clearly defined before specific road design is undertaken. The second logical step in the design process would then be the preliminary design of the mine development road and structures. Design of the bulk sample road would be the third step. The bulk sample road does not need to exactly follow the horizontal or vertical alignment of the development road, but it should be located so that as much as possible of the earthwork can be incorporated into the development road. However, temporary log bridges should be located so that they do not later interfere with construction of the high standard bridges. If the bulk sample road is located and designed in this manner, it can minimize costs of the development road by providing access to the top of rock cuts required for the final road, to both sides of bridge areas, and to the alignment as a whole. This ideal sequence of operations may not be possible because of project schedule demands. The bulk sampling road may need to be built before pipeline and mine development road designs are sufficiently advanced. Nevertheless, an integrated approach is recommended to the extent feasible.

6.2 ALIGNMENT CORRIDORS

The road alignment corridors must extend from a usable deep water terminal to the mine site at Quartz Hill. Field reconnaissance of the two proposed road corridors, Keta and Blossom, found them to be well located given the severe topographic restraints and the continuously falling grade requirement of the tailings pipeline.

During the field reconnaissance, we reviewed broad areas of terrain in the vicinity of the surveyed corridors to determine if shifts in the alignment, either to ease construction or to minimize impacts, were feasible. In each case the alternative considered was found to offer no advantage to the proposed corridor.

6.3 CONSTRUCTION MATERIAL

As noted previously, most of the soils in the project region are both highly organic and highly susceptible to disturbance. Glacial drift

deposits occur in small quantities along both road alignments. These deposits are not organic but are, nevertheless, highly susceptible to disturbance in the presence of excess water. Given the normal rainfall pattern in the region, it is usually not feasible to utilize soil materials for fill. Experience has shown that embankment construction can usually be accomplished only by using quarried rock.

Fortunately, virtually all of the rock encountered along either road alignment will provide good quality embankment fill. With rare exceptions, the material consists of intrusive igneous rock with a highly siliceous composition. This hard, dense material is not given to rapid weathering. In many places, suggestions of gneissic texture can be seen and very occasionally the texture becomes almost schistose. In general, however, the rock is neither highly jointed nor characterized by frequent partings. Pleistocene glaciations covered the area with thousands of feet of ice and, as a result, vitually all of whatever soil and weathered rock material existed has been scoured away and removed from the area. There has been little weathering or soil formation since the last glacial recession. This means that virtually all of the rock excavated for roadway construction should be usable as embankment fill. Currently available information does not suggest that any particular area would be favored as a source of crushed material for base material or asphalt production. It is probable that crusher sites can be located primarily on the basis of construction convenience rather than rock quality limitations. It would be desirable, however, to conduct a more detailed reconnaissance, and perhaps advance an exploratory boring, at desired crusher sites when the roadway design is more advanced.

If more rock fill is required than will be obtained from normal roadway excavation, a quarry site can be located at essentially any convenient position. It would appear that the most efficient way to obtain additional rock fill would be to expand the graded area at wharf locations and/or to widen road cuts at appropriate localities. In spite of all efforts to balance excavation and fill quantities in this manner, additional quarry

expectations or if zones of poor quality rock should be unexpectedly encountered. We expect that riprap should also be available from essentially any rock excavation. Where riprap is to be produced, care should be taken to design a blasting program that will produce sufficient quantities of the correct size material without excessive wastage or a significant need for secondary blasting. It may be that sufficient quantities of riprap can be produced by selectively taking material of appropriate size from rock cut areas as they are made and stockpiling it for later use in areas needing protection.

Concrete aggregate may be one of the more difficult construction materials to obtain in the project area. It can, of course, be crushed and screened from excavated rock but such material is less desirable than rounded gravel because it has detrimental effects on the "workability" of the concrete. Also, of course, it is more expensive to produce than material that can be simply bailed up and screened. Gravel could probably be obtained from any of the major rivers in the area but it seems unlikely that this would be permitted because of the potential fisheries impact. Perhaps a borrow pit could be sited on the fan of a large creek, such as Tunnel or Aronitz Creeks, well away from the stream. The few morainal deposits that we observed did not appear to be viable candidates for aggregate production since they contain large quantities of fine sand, silt, and clay size particles. A substantial washing and screening effort would be needed and would produce large quantities of waste. Depending on the quantities of aggregate required, it may be more efficient to barge it to the site from established facilities in the Ketchikan area (or elsewhere) rather than set up to produce it on site.

7.0 PRELIMINARY COST ESTIMATES

Preliminary cost estimates were prepared for the bulk sample road and the mine development road for both the Keta and Blossom route alternatives. Maintenance cost estimates were also prepared for both mine development road alternatives.

7.1 CONSTRUCTION COST ESTIMATING PROCEDURE

Preliminary construction cost estimates were prepared for the bulk sample road in 1976, and included an inflation factor to 1978 (Pool & Muench 1976). These costs were factored up to mid-1981, using ENR construction cost index. Timber purchase and removal costs were held constant at $120 per thousand board feet for purchase and $24.50 per thousand for removal (Pool and Muench 1976).

For the mine development road, preliminary construction quantities were estimated for each route based on type of terrain and construction. The quantities are listed in Table 4 and include only the major items required. Time and budget constraints did not allow for preliminary design of any of the elements of road construction. For example, there was no preliminary design of culvert sizes. The cost of drainage culverts was estimated by determining the approximate total culvert lengths required and applying unit cost data for the expected two most common sizes. Structure types and lengths were estimated in the field and construction costs estimated on a square foot or linear foot basis.

Unit prices were then applied to the quantities to determine the overall construction cost estimate. The unit prices used are listed in Table 5. These prices were developed after study of information from several sources. These sources included: (1) contractors' bids for similar type construction in southeast Alaska and other remote locations; (2) Forest Service cost data; (3) Washington State Department of Transportation bid item unit price tabulation factored up for construction in southeast Alaska; and (4) telephone interviews with contractors located in southeast Alaska and familiar with the project.

TABLE 4

APPROXIMATE QUANTITIES

Item	Unit	Keta Route	Blossom Route
Clearing and Grubbing	Acre	84	80
Excavation	Cubic yard	654,400	1,175,000
Embankment	Cubic yard	441,200	342,000
Unsuitable Excavation	Cubic yard	122,000	71,000
Riprap	Cubic yard	28,800	20,500
36-Inch Culvert	Linear foot	8,450	8,300
72-Inch Culvert	Linear foot	1,070	750
Guardrail	Linear foot	31,000	25,700
Concrete Barrier	Linear foot	5,500	13,400
Crushed Rock Base Course	Ton	66,000	66,000
Asphalt Concrete Pavement	Ton	39,000	39,000

TABLE 5

UNIT PRICES
(JUNE 1981)

Item	Unit	Unit Price
Roadway		
Mobilization, Keta Route	Lump sum	$1,000,000
Mobilization, Blossom Route	Lump sum	700,000
Clearing and Grubbing	Acre	5,000
Excavation	Cubic yard	9
Embankment	Cubic yard	7
Unsuitable Excavation	Cubic yard	6
Riprap	Cubic yard	25
36-Inch Culvert	Linear foot	60
72-Inch Culvert	Linear foot	200
Guardrail	Linear foot	25
Concrete Barrier	Linear foot	30
Crushed Rock Base Course	Ton	15
Asphalt Concrete Pavement	Ton	90
Steel Girder Bridge Structures (Design Loading AASHTO, HS 20)		
40- to 80-foot span	Square foot	$ 80
100- to 120-foot span	Square foot	130
200- to 300-foot span	Square foot	200

The unit costs of steel girder bridge structures were determined from studies of a similar bridge being planned at Kodiak, Alaska and contractors' bids for bridges constructed at difficult and remote locations.

The cost of snowshed structures was determined by factoring contractor bids for the snowshed shown on Figure 4. A check on these costs was obtained from studies of a railway snowshed now being planned in British Columbia. It is expected to cost $10,000 per meter ($3,000 per linear foot).

7.2 CONSTRUCTION COST ESTIMATES

The following cost estimates approximate construction costs in mid-1981. They include costs for purchase and removal of timber, but no costs for other fees or easements.

7.2.1 Bulk Sample Road

The estimated construction cost for the Keta route is $3.7 million; for the Blossom route it is $4.6 million. Timber purchase and removal costs are approximately equal for both routes at $0.6 million. Total costs are then $4.3 million for Keta and $5.2 million for Blossom.

7.2.2 Mine Development Road

The estimated costs for mine development road alternatives are contained in Table 6. The costs include providing space for the tailings pipelines along the road alignment, but do not include the cost of providing and placing the pipeline.

A check of the cost of the Blossom route was obtained by factoring up for inflation a contractor's bid for a similar highway constructed near Skagway. The factored per mile cost for the highway at Skagway is $2.2 million. Applying this to the 10-mile length of the Blossom route produces a cost of $22 million.

TABLE 6

PRELIMINARY CONSTRUCTION COST ESTIMATE
KETA ROUTE AND BLOSSOM ROUTE MINE DEVELOPMENT ROAD
(June 1981)

Item	Keta Route ($ million)	Blossom Route ($ million)
Road construction	$18.0	$20.9
Bridge structures	3.9	1.9
Snowsheds and defense works	3.8	--
Additional timber purchase and removal	1.2	1.2
Subtotal	$26.9	$24.0
Earthworks salvaged from bulk sample road	-3.7	-4.5
Subtotal	$23.2	$19.5
Contingency (10 percent)	2.3	2.0
Total Estimated Cost	$25.5	$21.5

7.3 MAINTENANCE COST ESTIMATES

Costs for maintaining the mine development road were estimated by obtaining actual highway maintenance cost data for two Cascade Mountain passes located in Washington State. These costs were for the winter of 1980-1981. Ice and snow removal costs were increased because that was a light snow year.

The cost data were then converted to a per-lane-mile cost and factored up for costs in southeast Alaska and the heavier snowfall at the project site. Application of these cost data to the mine road produced a cost estimate of $200,000 per year. This includes snow and ice removal, rock patrol, and slide removal.

For the first several years of operation these maintenance costs are believed to be approximately equal for both routes. The greater expected incidence of snowslide removal on the Keta route is expected to be balanced by a greater incidence of rock and debris removal required on the Blossom route. The significant difference in maintenance costs between the routes

is that the Keta will require an additional yearly maintenance cost of $50,000 to $100,000 for an avalanche control program. The need to clear rock and slide debris from the Blossom route should decrease with time.

The approximate yearly maintenance cost in 1981 dollars is $300,000 for the Keta route and $200,000 for the Blossom route.

8.0 CONCLUSIONS

Construction of the bulk sample road and the mine development road is feasible along either the Keta or Blossom routes.

Costs for construction of the bulk sample road are 21 percent higher for the Blossom route than for the Keta route. However, mine development road costs are about 18 to 19 percent higher for the Keta route. In addition, yearly development road maintenance costs are expected to be about 50 percent higher for the Keta route.

Soil and rock conditions along either route corridor do not present any exceptional problems with reference to major construction projects in southeast Alaska. The rock is generally stable and of good quality; it will provide rock fill material and can be crushed, if desired, to produce various kinds of aggregate. The surficial soils are usually highly organic and prone to serious loss of strength when disturbed. They will need to be wasted. Shallow landslides of soil off the underlying rock will occur and will be most frequent in the steeper terrain areas. Such slides can be minimized by careful control of construction but cannot be eliminated.

In the interest of overall project efficiency, it would be desirable to complete preliminary design of the tailings pipelines and the mine development road before final design of the bulk sample road. If this is not possible, care should be taken to assure that the bulk sample road is as close as possible to the mine development road alignment and that temporary bridges are close to, but not exactly at, permanent bridge locations.

9.0 BIBLIOGRAPHY

American Association of State Highway Officials, 1965. A policy on geometric design of rural highways.

Charles Pool & Associates, Inc., 1978. Phase one, Quartz Hill access road for Pacific Coast Molybdenum Company.

Dames & Moore, 1972. Report of engineering geologic and hydrologic studies, proposed Carlanna Lake Dam improvements, Ketchikan, Alaska. For Ketchikan Public Utilities.

Harris, et al., 1974. The forest ecosystem of southeast Alaska. Vol. 1, The Setting, USDA, Forest Service General Technical Report, PNW-12.

Pool & Muench, 1976. Report on Quartz Hill access road reconnaissance, location, and comparative construction cost estimates.

Sorensen et al., 1976. Exploration and development road analysis, Beaver route vs. Hill Creek route. U.S. Forest Service Internal Report.

U.S. Borax. Proposed mining access road, Tongass National Forest. Final Environmental Statement, USDA, Forest Service, Alaska Region.

U.S. Borax, 1981. Development concepts for the Quartz Hill molybdenum project. With Kaiser Engineers, Inc.

Wilson, N.A., 1978. Quartz Hill avalanche study - preliminary report. Prepared for U.S. Borax and Chemical Co. Snow Consultant Services, Norden, Calif.

______, 1979. Snow, avalanche studies at Quartz Hill. Winter report - 1978-1979. Snow Consultant Services, Norden, Calif.

______, 1980. Snow, avalanche studies at Quartz Hill. A summary 1978-1980. Snow Consultant Services, Norden, Calif.

APPENDIX C

AVALANCHE ANALYSIS

Prepared by:

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TABLE OF CONTENTS

SUMMARY

Two alternative road routes have been proposed for development of the Quartz Hill molybdenum deposit: one would follow the Blossom River drainage, the other the Keta River drainage (Figures 1 and 9). Potential avalanche hazards differ considerably between the proposed routes.

The Blossom River route has a low degree of avalanche hazard. Avalanches threaten this road for a combined length of approximately 200 yards. The majority of avalanche terrain lies on a steep hillside approximately 400 yards west of the Raspberry Creek crossing. The road at this location intersects approximately 150 yards of steep (greater than 30°), short (200 vertical feet) avalanche terrain that discharges small avalanches with almost every significant snowfall. Most of these discharges are relatively harmless although hazardous accumulations of snow do occur occasionally.

The Keta River route has a high degree of avalanche hazard. This route requires extensive avalanche defenses or a full-time control program to bring the hazard level down to an acceptable level by current standards. Approximately 1,100 yards of prospective road are threatened. Most of the avalanche paths are in the Hill Creek drainage. Avalanches crossing the valley floor and ascending to road level on the west side of Hill Creek are not anticipated. At some locations, avalanche paths discharge dangerous avalanches at least five times per year. Avalanche defenses, including facilities required for several complicated creek crossings, would be expensive with costs dependent on the options chosen. An active avalanche control program would probably cost between $50,000 and $100,000 a year. Although avalanche defense systems could reduce the hazard level to those encountered on some public highways[1] with avalanche problems, the hazard would still be considerably higher than the Blossom route. The Keta River route would also have occasional closure periods of up to 12 hours with control measures and an average annual closure time of at least 50 to 60 hours. These closure times would be reduced somewhat by the installation of defense structures.

In summary, from the standpoint of avalanche control the Blossom River
te is considerably safer and less expensive than the Keta River route.
Keta River route can be "controlled" to the current "state-of-the-art,"
the hazard cannot be eliminated. If a comprehensive avalanche control or
ense system were installed on the Keta route, the hazard level would be
uced to a level comparable to that accepted for some public highways.

INTRODUCTION

The molybdenum mine proposed by U.S. Borax is located east of Ketchikan in steep mountainous terrain. Two alternative access roads to the mine have been proposed: one following the Blossom River drainage, the other the Keta River drainage. Both routes intersect avalanche terrain.

Studies of avalanche potentials in the project area have been sponsored since 1978 by U.S. Borax (Wilson 1978, 1979, 1980) and have produced extensive documentation of avalanche areas. This study for the U.S. Forest Service focuses specifically on an analysis of avalanche hazards along the alternative road alignments.

Field investigations were conducted in early June 1981. Aerial reconnaissance delineated the location and extent of avalanche paths along the road routes. Ground surveys of terrain features revealed important characteristics necessary to determine frequency, magnitude, and mitigation procedures.

Avalanche mitigation techniques are classified as either control or defense measures. Control measures usually involve a monitoring or data collection system and creation of small avalanches to prevent excessive snow accumulations. Defense measures usually involve construction techniques to minimize avalanche hazards.

Avalanche defenses are commonly used along roads that must remain open to traffic. The hazard level presented to travelers is considerably lower with proper defense structures than with a control program. Avalanche defenses do not always preclude a control program but could reduce the control requirements.

CONTROL

Small avalanche paths along the road routes could be controlled with an avalauncher. This device launches an explosive projectile from a vessel pressured with compressed nitrogen. The system is accurate at 1,500 yards and effective up to 2,500 yards with some loss of accuracy. Its arched trajectory enables the avalauncher to be used in areas with thick coastal tree vegetation. The avalauncher costs $1,000. Ammunition averages $10 per round; approximately 500 rounds would be required per year if a control program for the Keta River route were initiated as described in the next section.

Large avalanche paths could be controlled with radio controlled projectile launchers. This equipment consists of a bank of 6 tubes with explosive projectiles and a launcher. Each launcher is numbered and connected to a radio receiver. A transmitter, with complex access codes to avoid accidental launching, is usually carried in a vehicle. The transmitter is keyed after road closures are in effect and the control director is in a location to observe results. This system allows for all-weather avalanche control, but costs a minimum of $20,000 for each set of 6 tubes. Four sets would be required to cover the avalanche starting zones that are out of range for the avalauncher on the proposed Keta River route.

In addition to expense considerations, a potential safety problem exists with the projectile launchers. Banff National Park developed the original system in 1976 in response to a demand for remote, non-artillery control. Tests conducted after the system was operational revealed that once armed, usually in early winter, the tubes could misfire and explode if tampered with by someone not familiar with their use.

Considerable development effort would be necessary to make this equipment safe and reliable to the level of performance desired. An alternative to the tube launchers is to bury "strings" of charges and use the same radio controlled triggering mechanisms. This is the method currently used in Canada. The problems associated with this method are: 1) a necessity to replace the "strings" of charges in avalanche starting zones periodically, and 2) the possibility of an avalanche carrying unexploded charges downhill.

Case blasting, the detonation of a larage charge at or near the roadbed, would effectively control short, steep slopes above the road. The aerial shock waves shake loose snow from the steep slopes above.

Avalanche control during clear weather could be accomplished by helicopter bombing. Charges are made up with a cap and fuse. Slow helicopter passes are made while the lit charges are dropped. This method is both fast and cost effective but is limited to good visibility periods, a rare phenomenon at Quartz Hill.

Another control method uses military artillery. However, acquisition is difficult, equipment costs are high, and the use of military artillery would require a full-time Forest Service person under co-operative agreements. In most avalanche areas along the road routes, thick trees block the firing visibility for a flat trajectory artillary piece such as a recoiless rifle. This cannot be considered a viable control option.

Control work is necessarily timed by stability factors. A method of forecasting avalanches is necessary to control programs and requires data input of meteorological parameters from remote locations. These parameters

would include temperature, wind speed and direction, snowpack temperatures, solar radiation, humidity, barometric pressure, and precipitation. Depending on the design of a data gathering system, equipment costs could range from $20,000 to $30,000.

Manpower required for a control project on the road would number at least two to three full-time positions during the snow season. This estimate does not include any work that might be necessary at the mine location. Manpower would also be needed for approximately three months during the summer for record keeping, instrumentation and maintenance.

DEFENSES

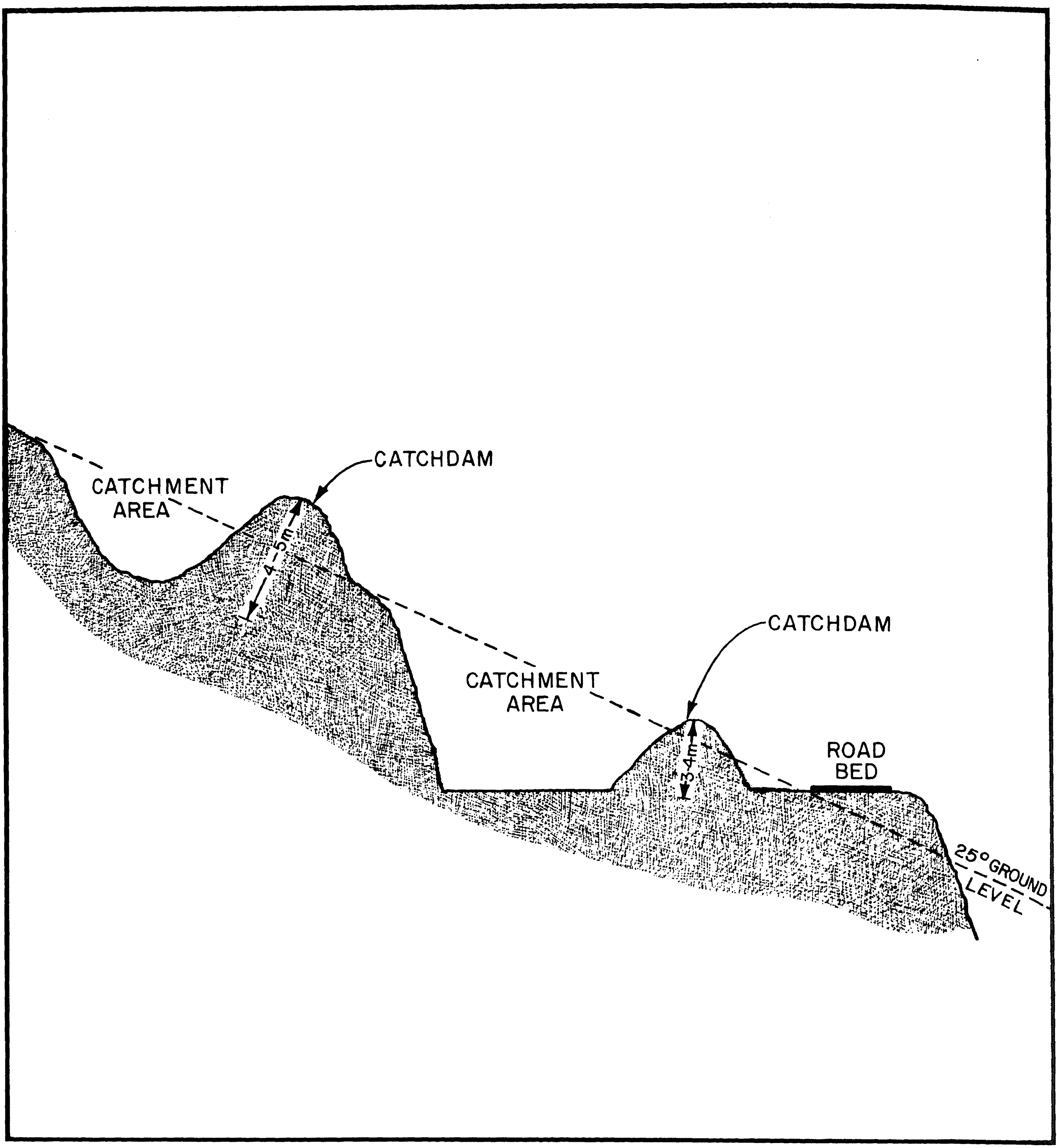
Snowsheds built into steep hillsides along railroad and highway corridors are common defense structures. They allow moving snow and entrained debris to slide over the highway on an overhead roof. Typical construction costs range from $3,000 to $6,000 per linear foot (Peter Schaerer, National Research Council of Canada, personal communication, 1981). A negative feature associated with snowsheds is that groundwater may freeze on the roadbed inside the shed and present as great a hazard to traffic as avalanches. Careful analysis of cost to benefit would be necessary before snowsheds could be recommended. In all likelihood, the hazard from icing would exceed the safety benefit due to relatively few avalanches reaching the road every year.

Earth mounds and diversion dikes are defense structures used to deflect and break the momentum of rapidly moving snow. They are quite effective at dissipating this energy if there is sufficient distance between the start of the run-out zone (where an avalanche begins to decelerate) and the road. Their use is not considered effective above a slope angle of 20°. Native soils are commonly pushed by bulldozers into mounds or dikes up to 30 feet high. Problems with soil stability and drainage would likely be encountered, making the use of heavy equipment impossible in some situations. Expenses involved would be limited to equipment time. Some environmental impact would result from terrain disturbance and increased exposure to erosion. However,

nse structures would be located in areas that are naturally disturbed odically by avalanches.

Bridges spanning deep gullies can be used as defense structures if only slow moving avalanches reach the crossing locations. A dry, fast moving anche has sufficient flow depth to damage bridge structures.

Catchdams could be constructed to intercept slower moving avalanche is and provide a deposition location prior to the road. These would be ly effective in the locations described but would have to be cleaned by y equipment after every significant avalanche event. Careful attention d have to be given to their design to serve the dual requirements of anche defense and ease of snow removal. The basic design of catchdams ows for better drainage and less erosion than with earth mounds. nding on the design, costs could run from $20 per lineal road foot for hworks to $1,000 per lineal road foot for large concrete catchments. e could be built primarily on an extra wide roadbed, with additional dams ope as avalanche frequency and topographic factors dictate. A typical e profile for catchdams above and adjacent to a road is shown on Figure



CATCHDAM DESIGN

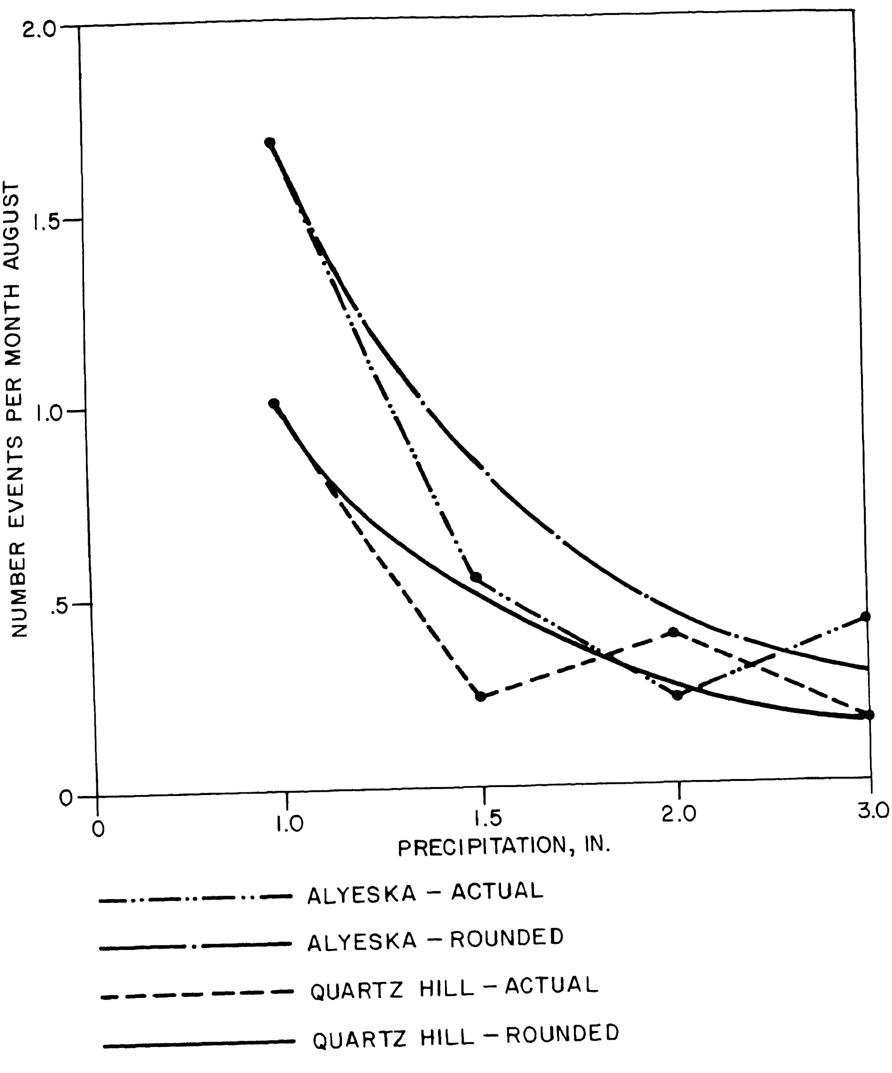
WEATHER AND AVALANCHE OCCURRENCE SUMMARY

Natural and controlled avalanche activity has been estimated to allow for more realistic estimates of road down-time, and the advisability of defensive structures versus avalanche control.

Precipitation and temperature data from Quartz Hill were examined and broken down into single day storms in excess of 1-inch precipitation with additional categories of 1.5, 2, and 3 inches. From this, storm cycles were isolated for comparison of large magnitude events. The same process was applied to data from Mt. Alyeska, an alpine observation site with active avalanche control. The idealized curve comparing data from Quartz Hill and Mt. Alyeska is shown on Figure 2.

Compared to Mt. Alyeska, Quartz Hill received only 60 percent of the large magnitude (<1 inch) storms over the past 5 years. Anticipated controlled avalanche activity would consequently be about 40 percent less at Quartz Hill than at Mt. Alyeska if other factors are the same. The relatively short time of 20 months that winter data is available for Quartz Hill casts some doubt on the validity of this figure. Longer term data will allow for a more refined analysis.

One factor that would make a significant difference between the two sites is the presence or absence of cold air masses over each site for extended periods of time. These cold air masses generally form very unstable snow crystals. Often it takes several storms before avalanches start to run on these unstable layers, most commonly referred to as temperature gradient (T.G.) snow. For this reason, single-day storms were examined to determine storm cycles capable of producing large magnitude avalanche events. A record of these storm cycles is shown on Table 1. This record also shows the temperature trend prior to the onset of the storm. A comparison of storm cycles to avalanche occurrences shows that a 1 to 5-day precipitation rate above 1.25 inches per day or a 5 to 20-day precipitation rate above .75 inches per day combined with a clear cold period prior to the storm period produce the largest amount of large magnitude avalanches. Alyeska shows a



COMPARISON OF PRECIPITATION ALYESKA - QUARTZ HILL

TABLE 1
STORM CYCLES - PRECIPITATION

QUARTZ HILL

Date	No. Days	Average Precipitation Per Day (inches)	Total Precipitation (inches)	Precipitation Sequence	Temperature Trend
Nov. 1-3, 1976	3	2.96	8.89	1.0, 1.0, 6.89	N/A*
Dec. 9 - 12, 1976	4	1.44	5.77	1.82, 1.09, 40, 2.46	N/A*
Feb. 12-14, 1977	3	1.64	4.93	1.66, .94, 2.33	N/A*
Nov. 28-29, 1977	2	1.33	2.67	1.33, 1.34	N/A*
Mar. 5-7, 1979	3	1.47	4.41	1.29, .69, 2.23	Cold & Clear Feb.
Dec. 25-27, 1979	3	2.52	7.56	1.14, 3.16, 3.04	See Figure 3.
Dec. 9-14, 1980	6	1.97	11.87	2.28, 3.12, .17, 1.32, 3.06, 1.92	See Figure 4.
Mar. 27-28, 1981	2	2.20	4.41	1.88, 2.61	Warm

*No data available.

MT. ALYESKA

Date	No. Days	Average Precipitation Per Day (inches)	Total Precipitation (inches)	Precipitation Sequence	Temperature Trend
Feb. 8-9, 1971	2	1.47	2.95	1.25, 1.70	Cold previously
Feb. 21-26, 1975	6	1.66	10.00	2.20, .90, .90, 1.65, 3.10, 1.25	Cold previously
Feb. 5-25, 1978	21	.93	19.55		
Sect. Feb. 5-7	3	.93	2.80	.20, 1.80, .80	Cold Dec.
13-14	2	1.65	3.30	1.10, 2.20	Moderate in Jan.
23-25	3	1.93	5.80	1.50, 1.30, 3.00	T.G. Development
March 12-16, 1978	5	1.08	5.40	1.40, .80, .30, 1.40, 1.50	Moderate
Dec. 1-3, 1978	3	1.10	3.30	.92, 1.33, 1.05	No Nov. record
March 20-22, 1979	3	1.45	4.37	1.25, .77, 2.35	Moderate til March 2
March 3-23, 1980	21	.69	14.66		Clear & Cold Feb.
Jan. 18-22, 1980	5	2.50	20.50	3.22, 3.84, .58, 3.04, 1.82	Clear & Cold 30 days
Jan. 19-20, 1978	2	1.32	2.65		Cold Dec. Mild Jan.

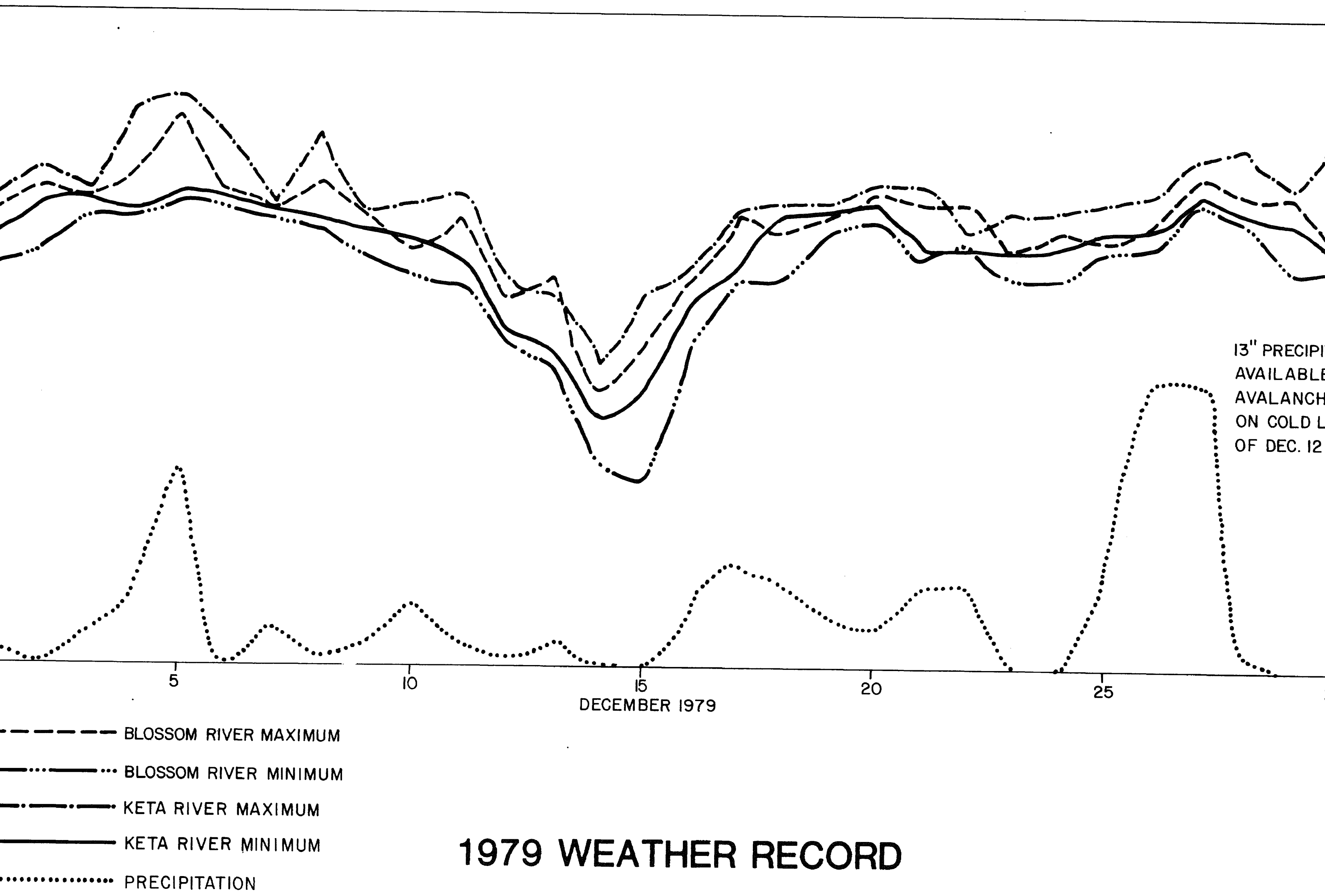
more pronounced tendency to extended cold periods, however, these same conditions also occur occasionally at Quartz Hill and would produce an avalanche cycle with the onset of precipitation.

Figures 3 and 4 illustrate temperature and precipitation patterns at Quartz Hill for two months that produced major storms.

Size classification of avalanches has been used as a magnitude indicator for numerous years. These sizes are given relative to each path:

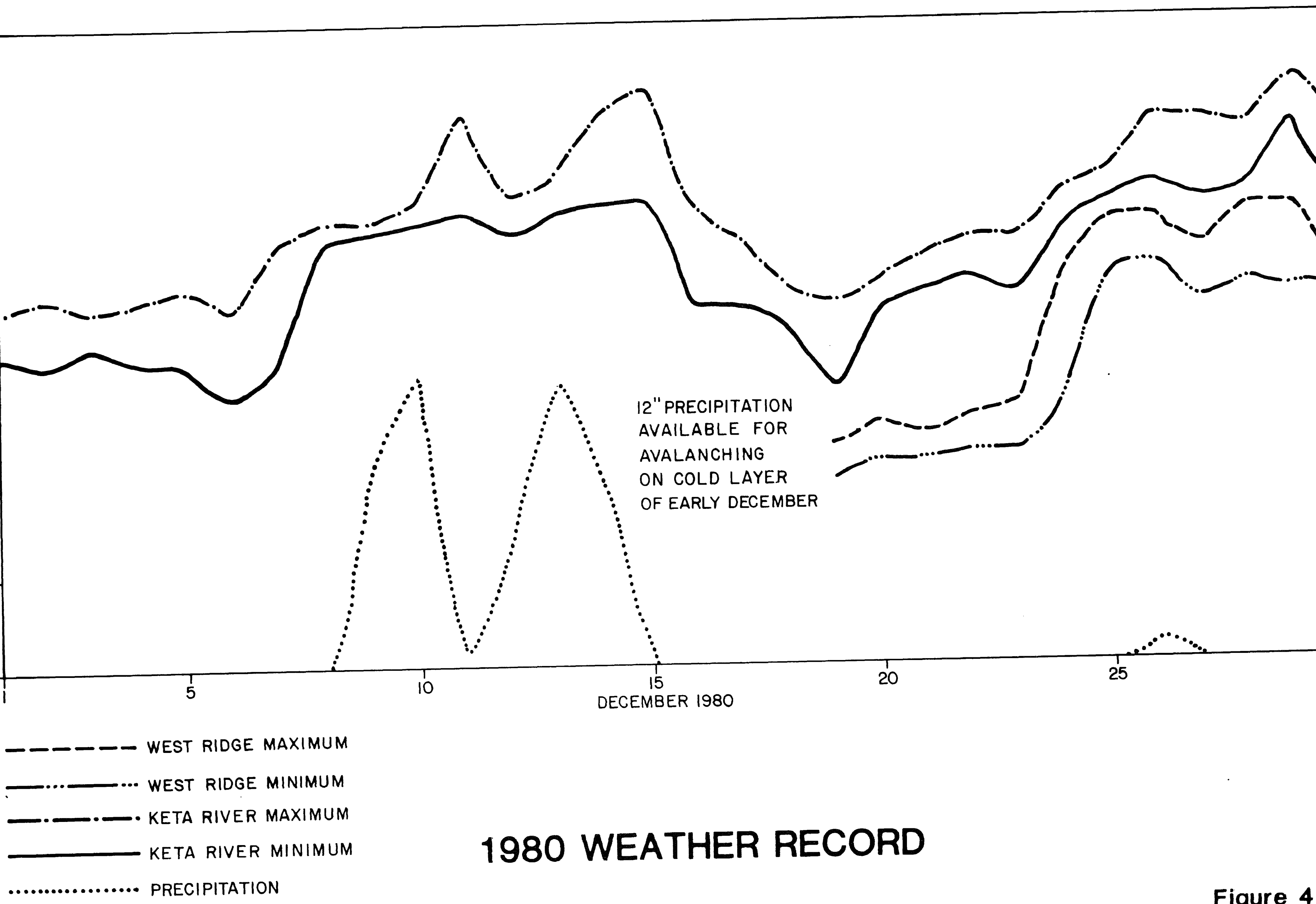
Class 1 - sluff, harmless
2 - small
3 - medium
4 - large
5 - maximum

Table 2 compares storm profiles to avalanche occurrence data from artillery control at Alyeska and natural avalanche activity along the Alaska Railroad. This table covers only larger magnitude avalanches. Table 3 gives estimates of avalanche occurrence frequency by slide path.



1979 WEATHER RECORD

Figure 3



1980 WEATHER RECORD

Figure 4

TABLE 2

LARGE MAGNITUDE AVALANCHES

Date	Alyeska/Controlled Class - Number	Railroad/Natural Class - Number
Feb. 8-9, 1972	4 - 5 5 - 1	4 - 2
Feb. 21-26, 1975	4 - 5 5 - 1	4 - 4
Feb. 5-25, 1978	4 - 7 5 - 7	5 - 2 4 - 4
Mar. 12-16, 1978	None	None
Dec. 1-3	None	None
March 3-23, 1979	4 - 5	5 - 4 4 - 4
Jan. 18-22, 1980	4 - 8	5 - 1 4 - 8
Feb. 1-10, 1980	4 - 8	4 - 9
Jan. 19-20, 1978	4 - 6 5 - 1	

	20 Avalanche paths	40 Avalanche paths	
Alyeska/Controlled	Railroad/Natural	Controlled vs. Natural	
Class 5 - 10 x 2 =[1] 20	Class 5 - 7	2.85	1
Class 4 - 44 x 2 = 88	Class 4 - 31	2.83	1

(1) Statistical adjustment for the difference between 20 and 40 avalanche paths.

TABLE 3

ESTIMATES OF AVALANCHE FREQUENCY

Class Slide to Reach Road (Avg. Conditions)	Estimated Minimum Precip. Required to Produce Size Class (inches)	Avg. No. of Precip. Events/yr. of Given Size at Quartz Hill	Estimated Controlled Avalanche/yr. Based on weather Data at Quartz Hill	Estimate Controlled Avalanche/yr. Alyeska occurrence Data -40%	Estimated Natural Avalanches/yr Railroad Data
2	1.0	6	6/yr.	9/yr.	3.15/yr.
4	6.0	0.6	1/1.6 yrs.	1/1.31 yrs.	1/3.73 yrs.
3	2.0	3	3/yr.	1.62/yr.	1/1.75 yrs.
5	10.0	0.2	1/5 yrs.	1/5.65 yrs.	1/16.1 yrs.
3	2.0	3	3/yr.	1.62/yr.	1/1.75 yrs.
3	2.0	3	3/yr.	1.62/yr.	1/1.75 yrs.
3	2.0	3	3/yr.	1.62/yr.	1/1.75 yrs.
5	10.0	0.2	1/5 yrs.	1/5.65 yrs.	1/16.1 yrs.
2	1.0	6	6/yr.	9 /yr.	3.15/yr.
5	10.0	0.2	1/5 yrs.	1/5.65 yrs.	1/16.1 yrs.

ALTERNATIVE ROUTE ANALYSIS

This section discusses the alternative Keta and Blossom road routes according to potential hazards and mitigation techniques. A key map is included for both routes to indicate avalanche paths (Figures 5 and 13). Photographs of each path along the road routes (Figures 6 through 12 and Figures 14 and 15) illustrate the potential hazard and are keyed to inventories (Tables 4 and 5) of possible control and defense measures. An inventory on each path includes:

1. An estimate of controlled avalanches reaching the road per year and closure times
2. Estimate of natural avalanche activity to the road per year and closure times.
3. Possible control procedures
4. Possible avalanche defenses
5. Recommended method of creek crossing
6. A hazard rating only for safety comparison purposes

Hazard ratings are established by an analysis of frequency and magnitude relationships. If a path discharges numerous avalanches every year, the chances of an encounter would be high and consequently the path would have a high hazard rating. If a path discharges very large avalanches, but does so infrequently, the hazard level would only be medium because of a low probability of encounter. Almost any size avalanche impacting the roadbed is potentially hazardous; therefore, frequency is the most important aspect of a hazard rating. However, the chances of surviving large magnitude events is so small that some consideration must be given to size as well.

The use of hazard ratings is too subjective for any purpose other than safety comparison. Even a low hazard rating path has some potential for

KETA RIVER ROUTE

Along the Keta River proper there are numerous small sluffs (small, innocuous, loose-snow avalanches) that will fall from steep banks above the road (Figure 5). These will not present a significant hazard. One-half mile from tidewater on the south side of the Keta River are several large avalanche paths. The present road configuration misses these, however, they would present a hazard if the road was constructed near them. As the proposed road moves into Hill Creek, the first (K-1) of seven major avalanche paths is reached. At two locations in Hill Creek (K-2, K-4) deep gullies must be spanned. Deep Creek (K-2) shows evidence of high speed airborne powered avalanches that would preclude construction of a bridge. Notch Creek (K-4) shows evidence of slow, wet avalanches that would allow a bridge defense system. The remainder of the road from K-7 to Quartz Hill is sufficiently removed from steep hillsides and should not be susceptible to avalanche hazards.

Design impact studies would be necessary for any defense structures proposed for the Keta route.

BLOSSOM RIVER ROUTE

Ascending from Wilson Arm, the first avalanche path crossed is at No. 3 Creek (Figure 13). This path (B-1) would avalanche so infrequently to the road that no significant hazard is forseen. Approximately 400 yards west of Raspberry Creek avalanches would occur along 200 yards of steep banks (B-2). These avalanches would close the road occasionally and present some low levels of hazard. On the east side of Beaver Creek are several small areas (B-3) that avalanche underneath the tree canopy and do not present a significant hazard.

TABLE 4
CONTROL AND DEFENSE ALTERNATIVES - KETA ROUTE

Alternative Emphasizing Active Control Techniques

	Creek Crossing	Defensive Structures	Control	Number of Closures Per Year	Average Closure Period	Hazard Level
K-1	Cut & fill	None	Avalauncher from road	9	3 hr.	High
K-2	Cut & fill w/very large culverts	Large culverts allow small wet slides to pass through	Radio controlled projectile launchers or avalauncher	1	12 hr.	Medium
K-3	Standard road construction	Catchdams	Avalauncher or radio controlled projectile launchers	3	3 hr.	Medium
K-4	Bridge	Bridge to allow wet snow under	None	None	0	None-low
K-5	Standard road construction	Catchdams	Avalauncher	3	3 hr.	Medium
K-6	Standard road construction	Catchdams	Avalauncher	3	3 hr.	Medium
K-7	Standard road construction	None	Avalauncher	3	1 hr.	Low

Alternative Emphasizing Defense Structures

	Creek Crossing	Defensive Structures	Control	Number of Closures Per Year	Average Closure Period	Hazard Level
K-1	Cut & fill with snowshed on top	Snowshed	None	None		None
K-2	Cut & fill with snowshed on top	Snowshed	None	None		None
K-3	Standard road construction	Catchdams and diversion dike	Helicopter, avalauncher	1	3 hr.	Low
K-4	Bridge	Bridge to allow wet slides under	None	None	0	None-Low
K-5	Standard road construction	Catchdams	Helicopter, avalauncher	3	3 hr.	Medium
K-6	Standard road construction	Catchdams	Helicopter, avalauncher	3	3 hr.	Medium
K-7	Standard road construction	None	Helicopter, avalauncher	3	1 hr.	Low

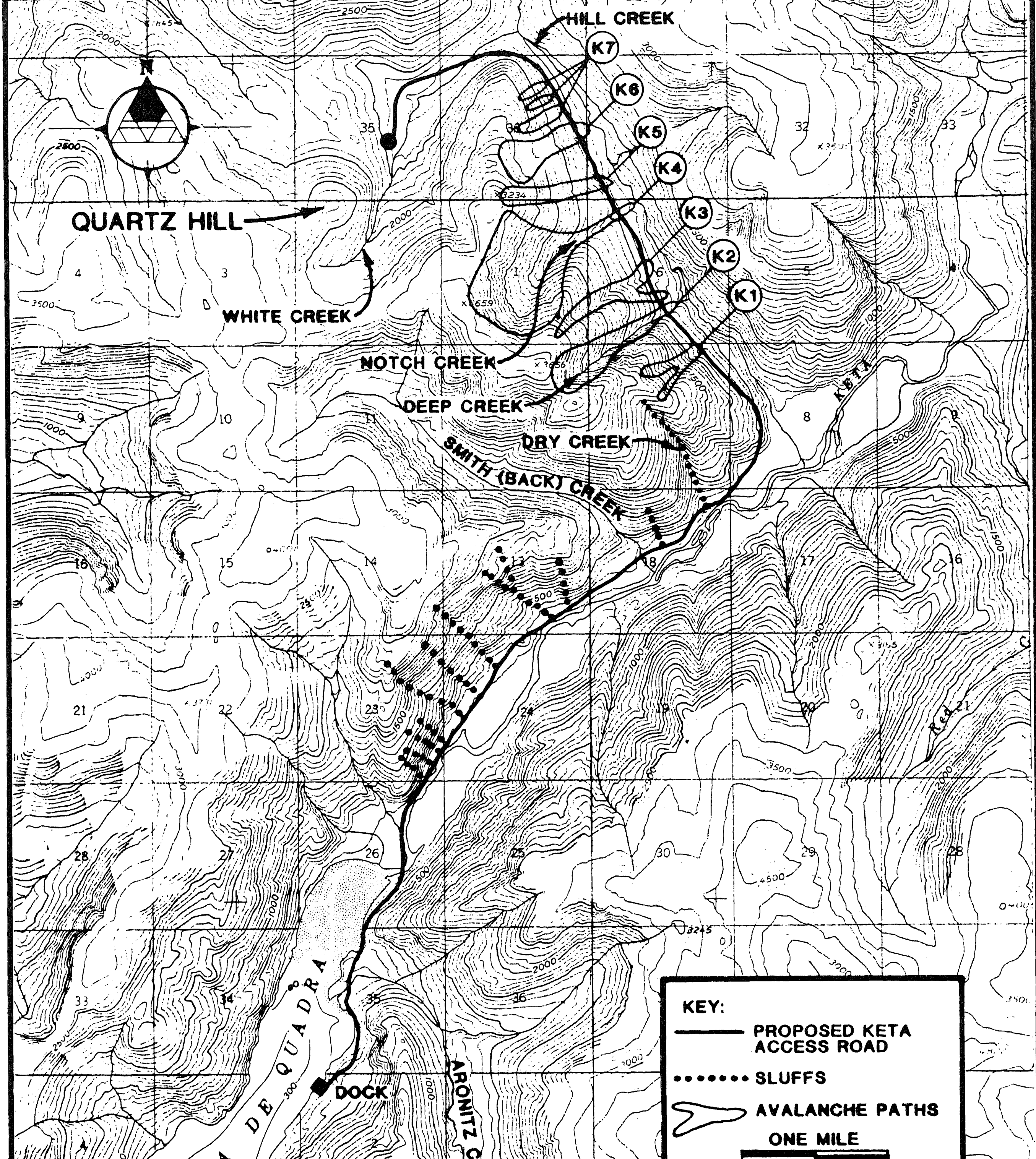
TABLE 5
CONTROL AND DEFENSE ALTERNATIVES - BLOSSOM ROUTE

Alternative Emphasizing Active Control Techniques

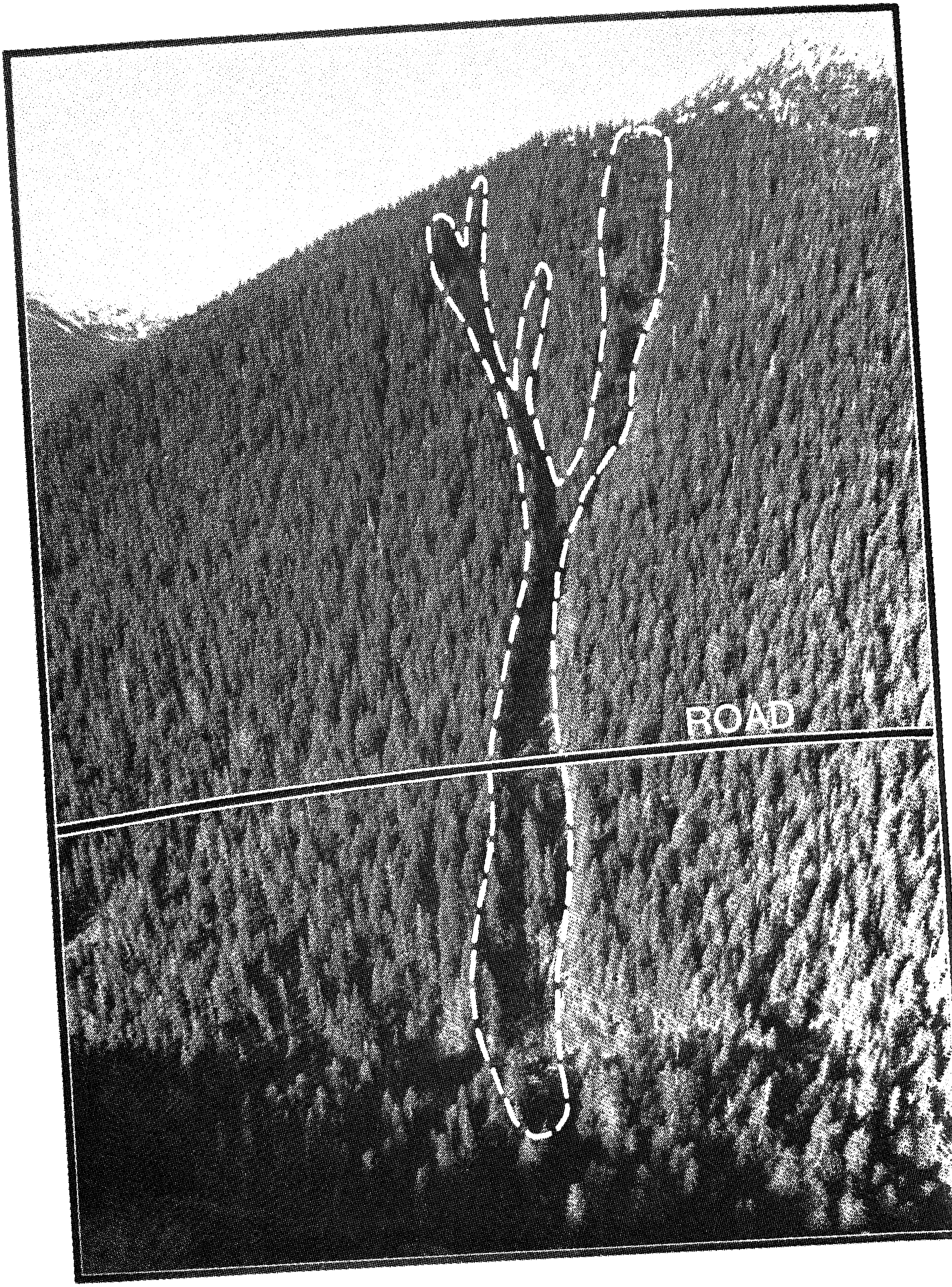
	Creek Crossing	Defensive Structures	Control	Number of Closures Per Year	Average Closure Period	Hazard Level
1	Bridge	Bridge to allow wet snow under	None	None		None-low
2	Standard road construction	None	Avalauncher	6 - 9	1 hr.	Low
3	Standard road construction	None	Avalauncher	None		None-low

Alternative Emphasizing Defense Structures

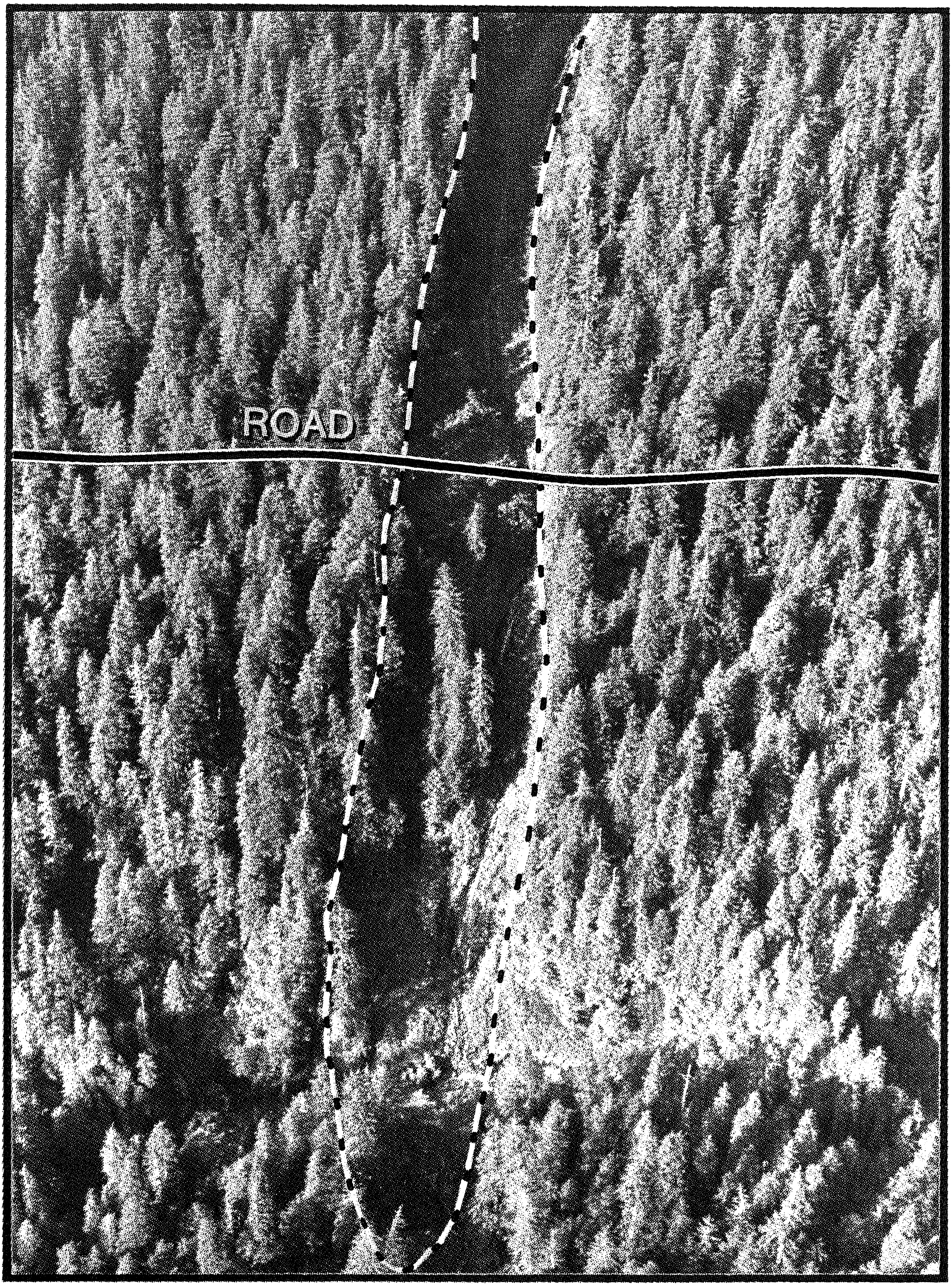
	Creek Crossing	Defensive Structures	Control	Number of Closures Per Year	Average Closure Period	Hazard Level
1	Bridge	Bridge to allow wet snow under	None	None		None-low
2	Standard road construction	Snowshed	None	None		None
3	Standard road construction	Relocate road 100' downhill	None	None		None



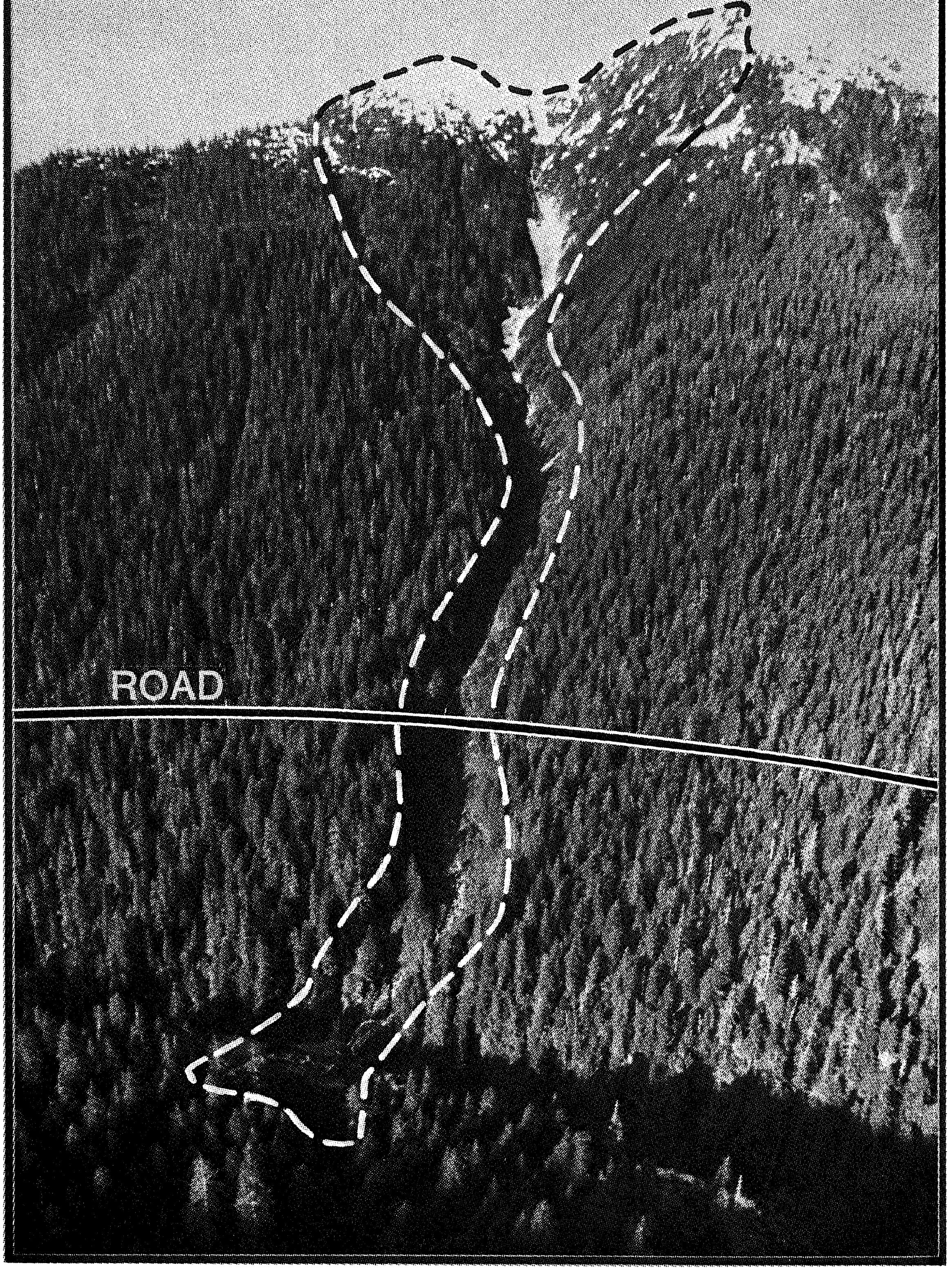
QUARTZ HILL ACCESS ROAD
KETA ROUTE



OVERVIEW OF AVALANCHE PATH K-1

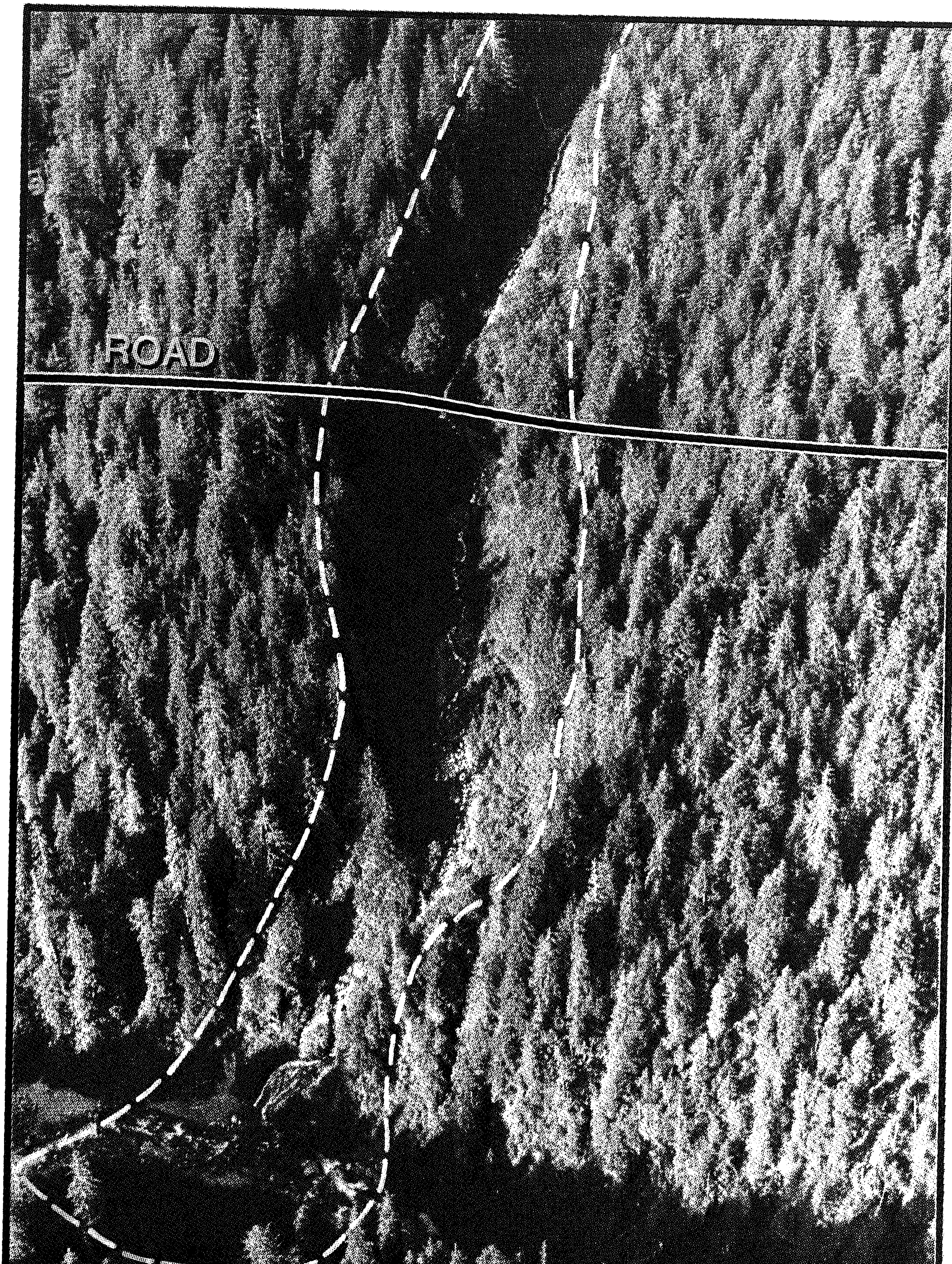


SECTION OF AVALANCHE PATH K-1



OVERVIEW OF AVALANCHE PATH K-2

Figure 7a



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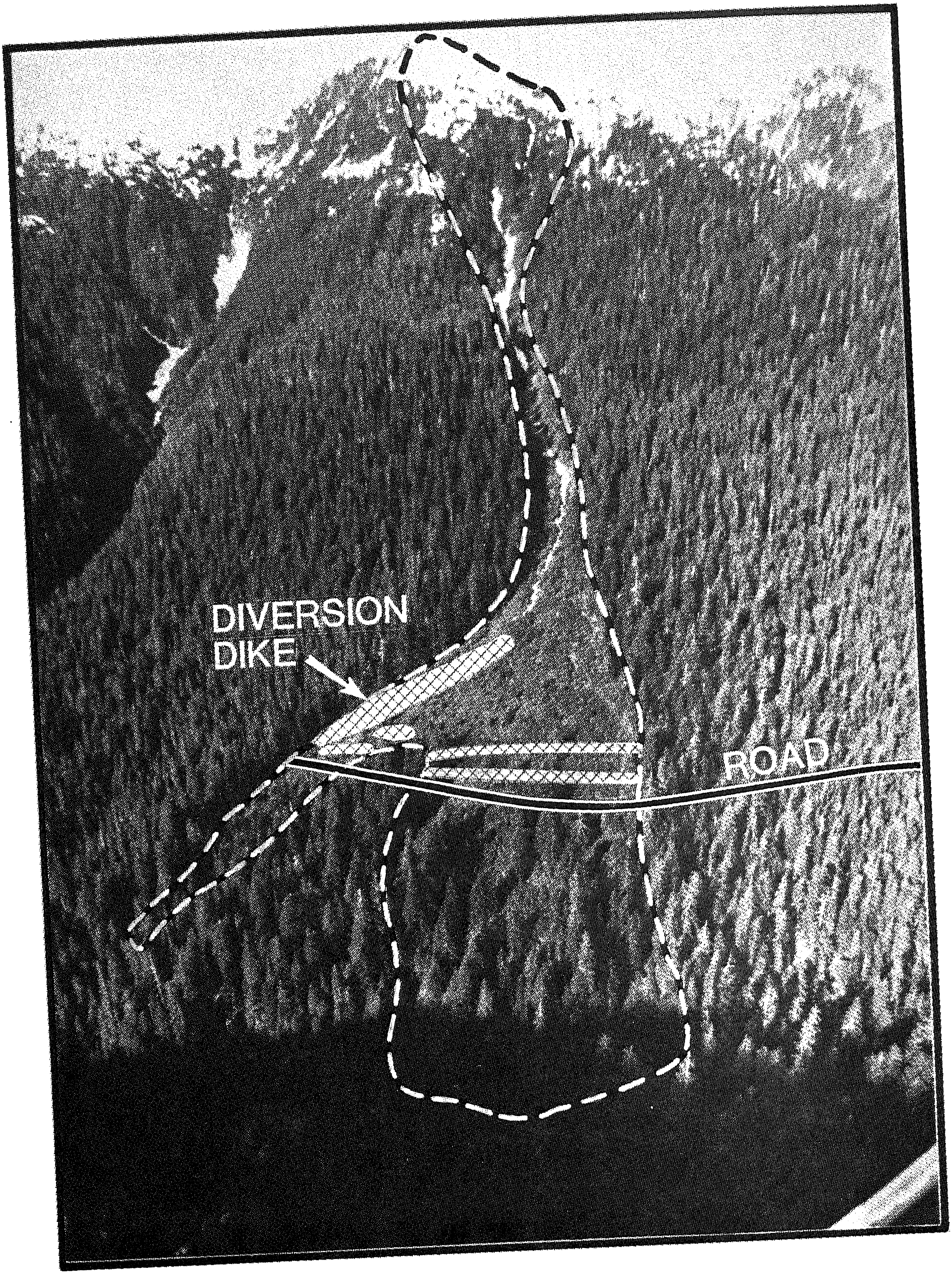
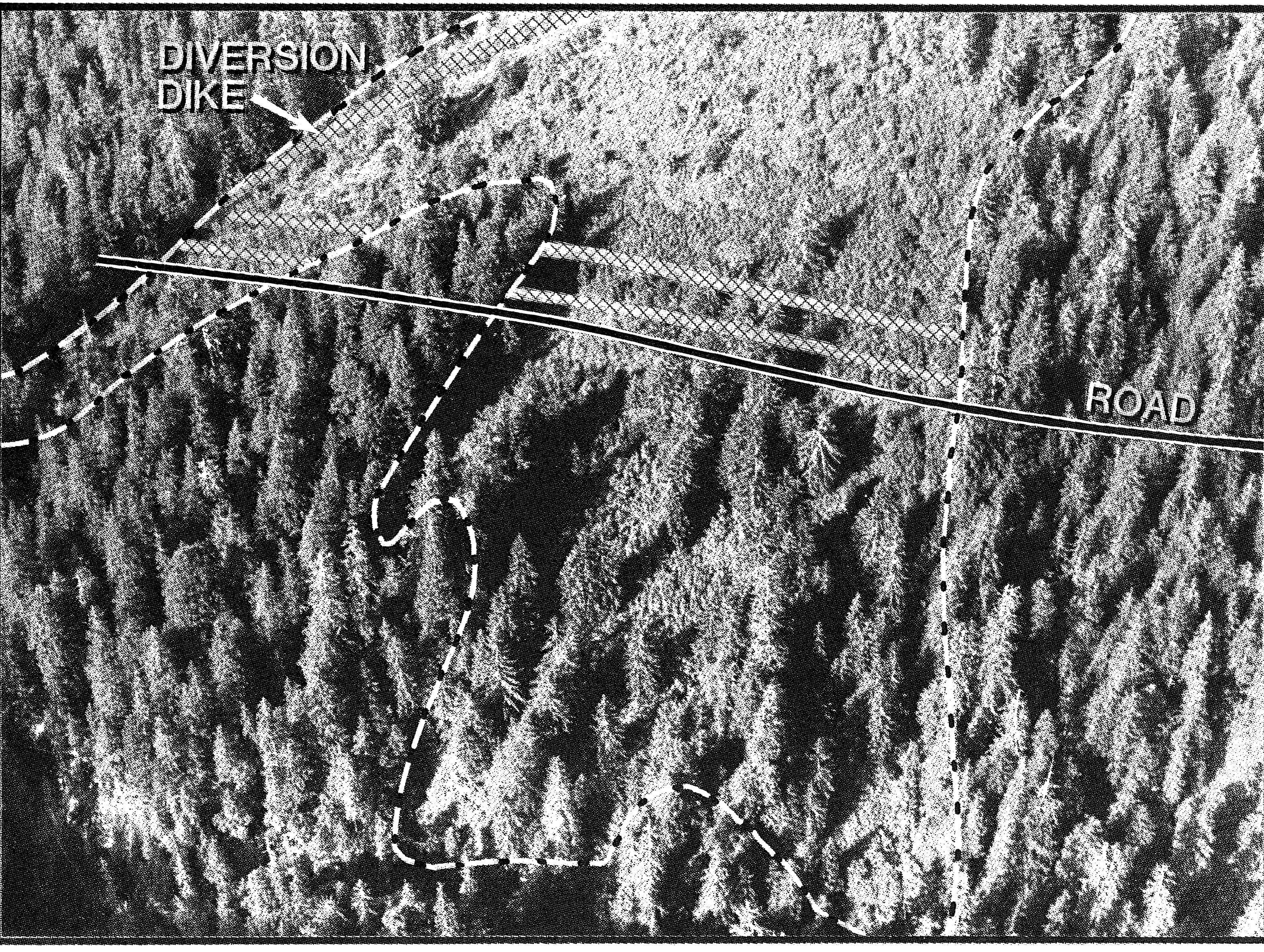
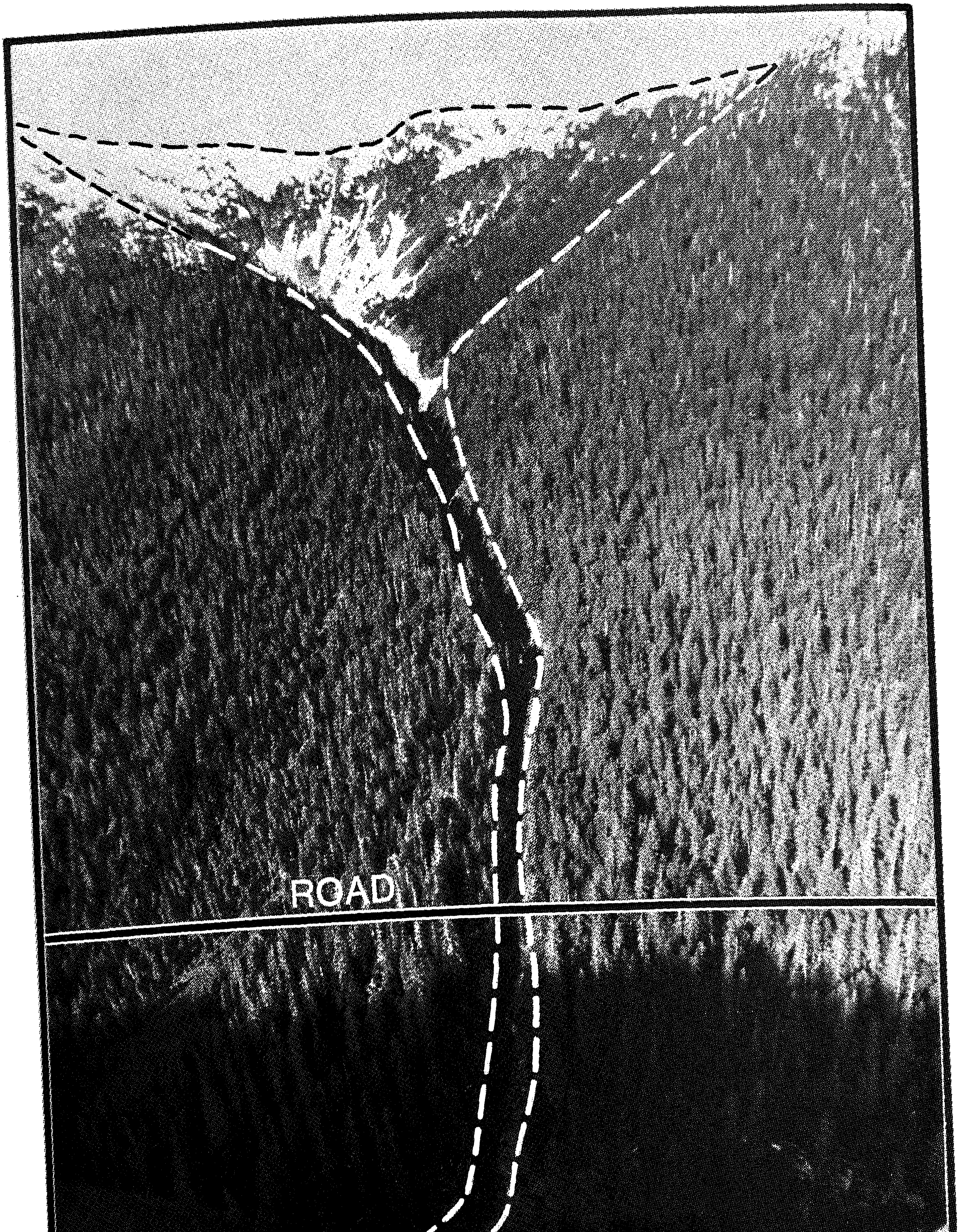


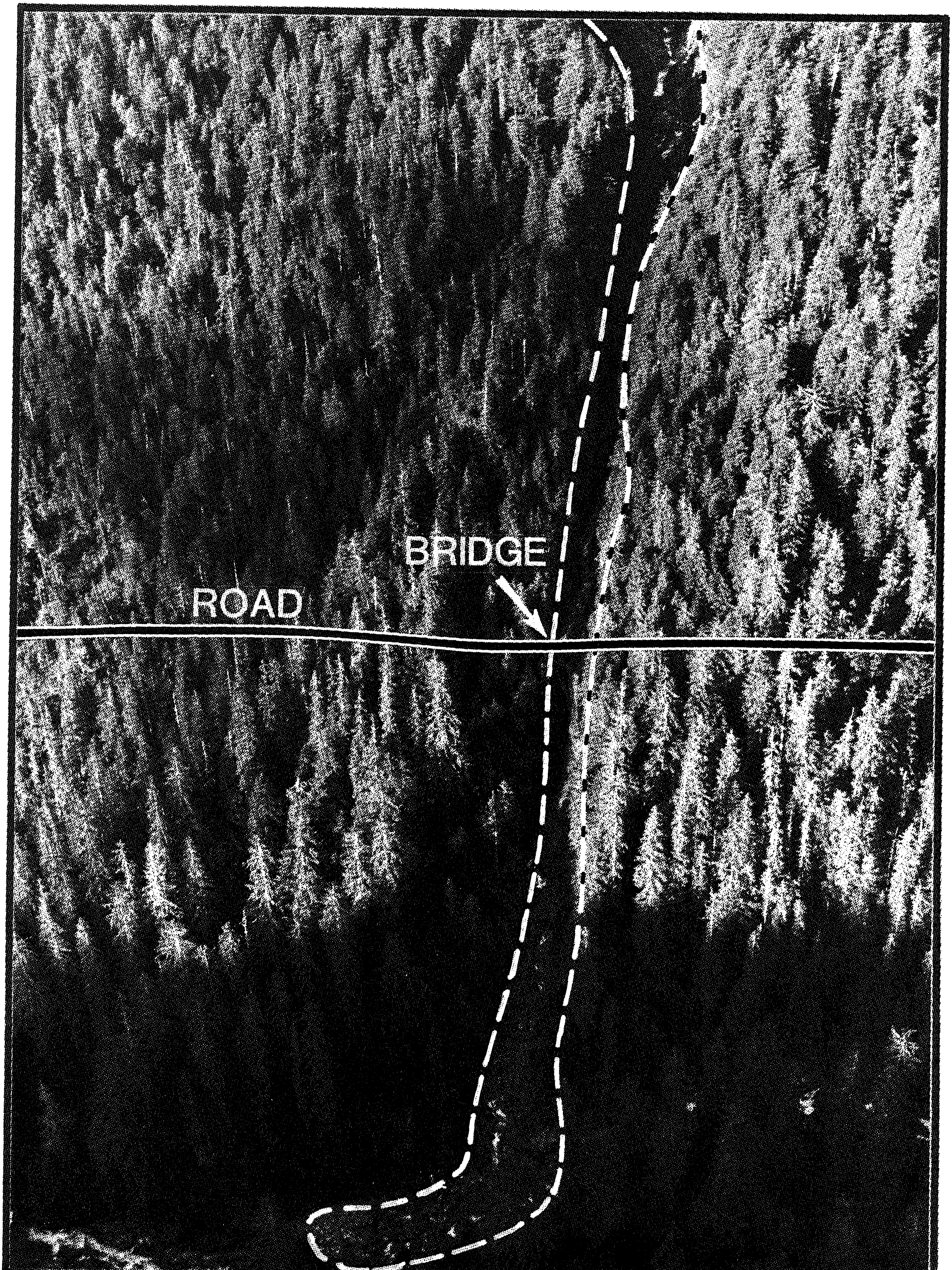
OVERVIEW OF AVALANCHE PATH K-3



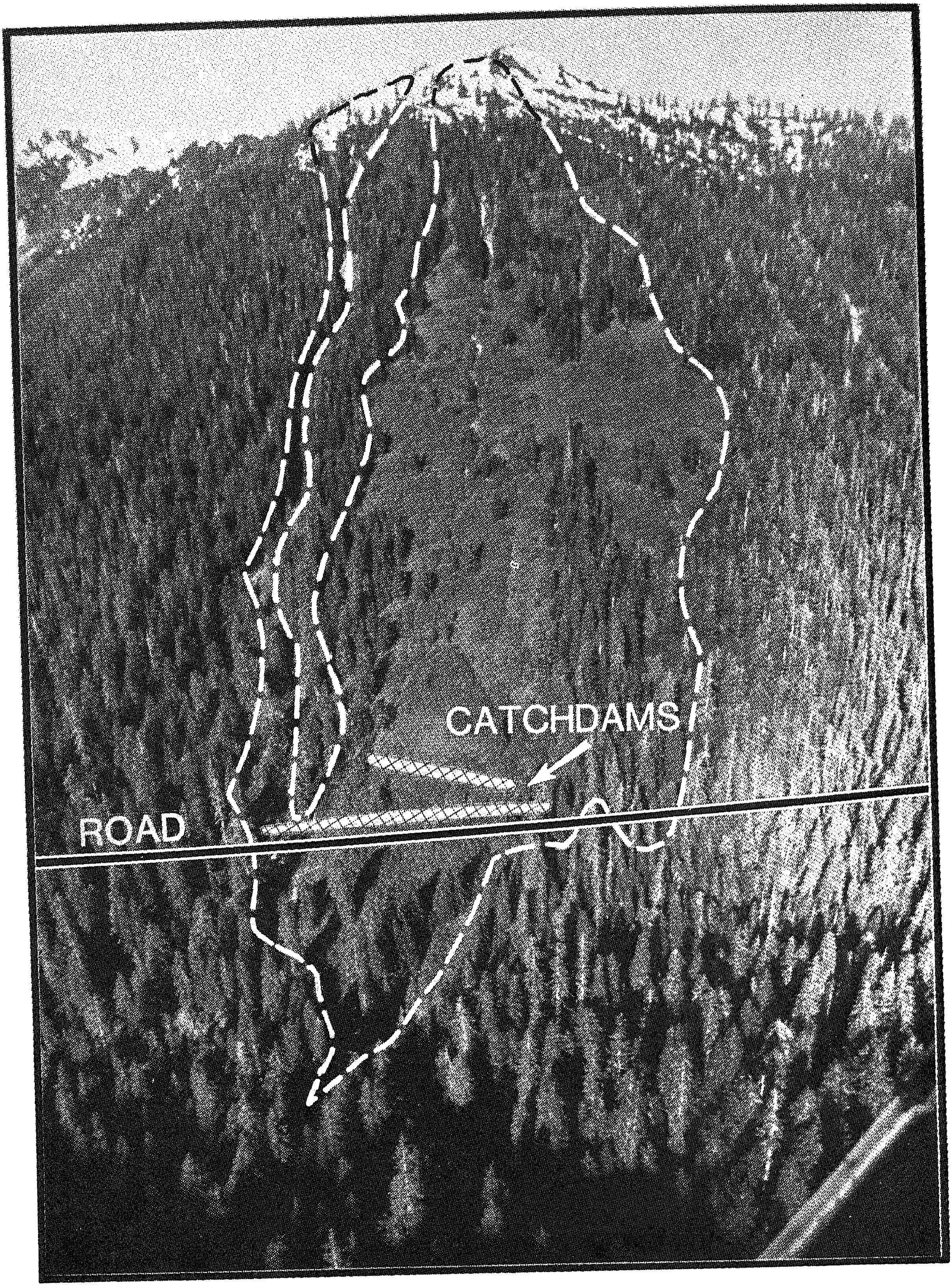
SECTION OF AVALANCHE PATH K-3



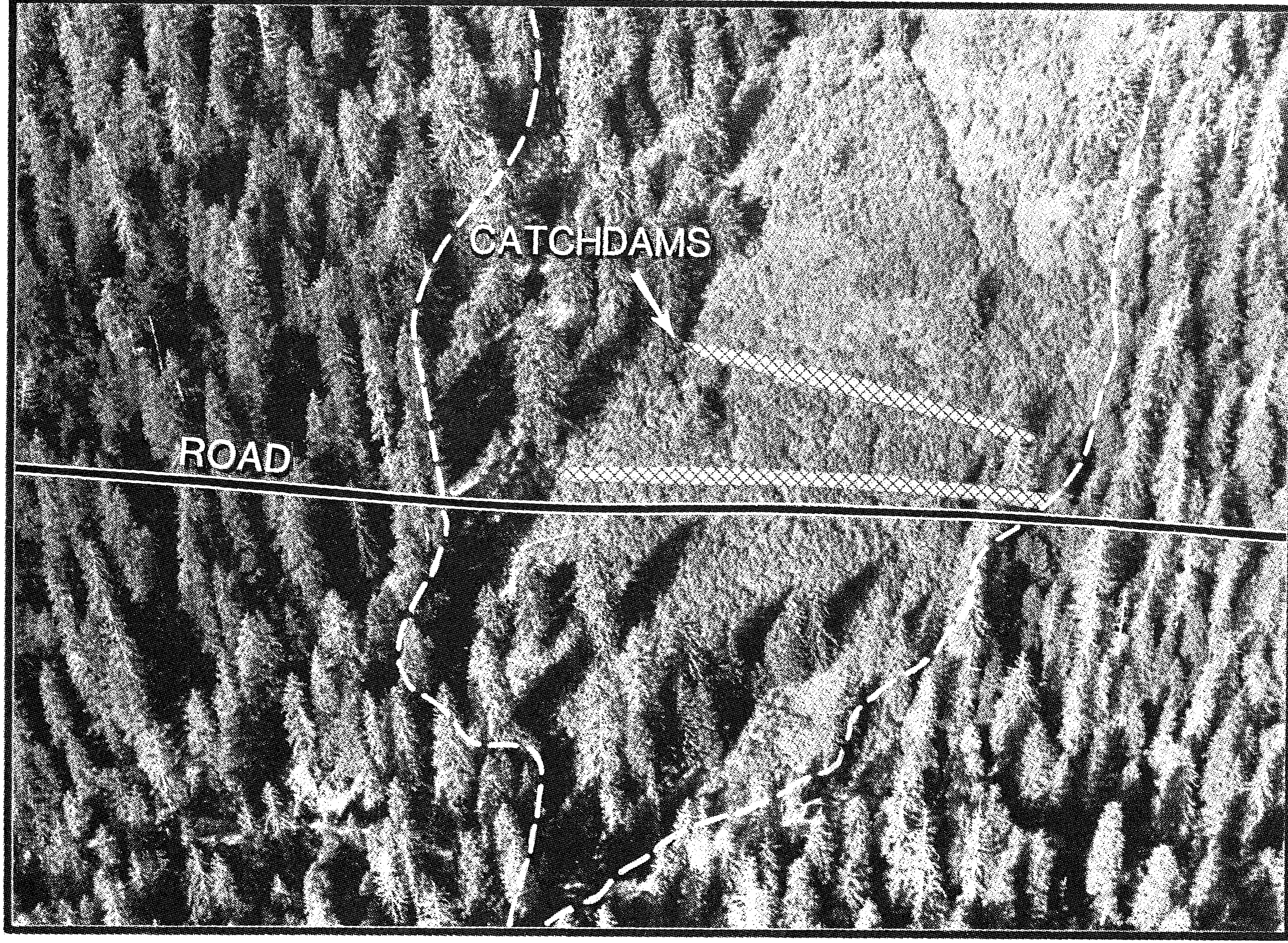
OVERVIEW OF AVALANCHE PATH K-4



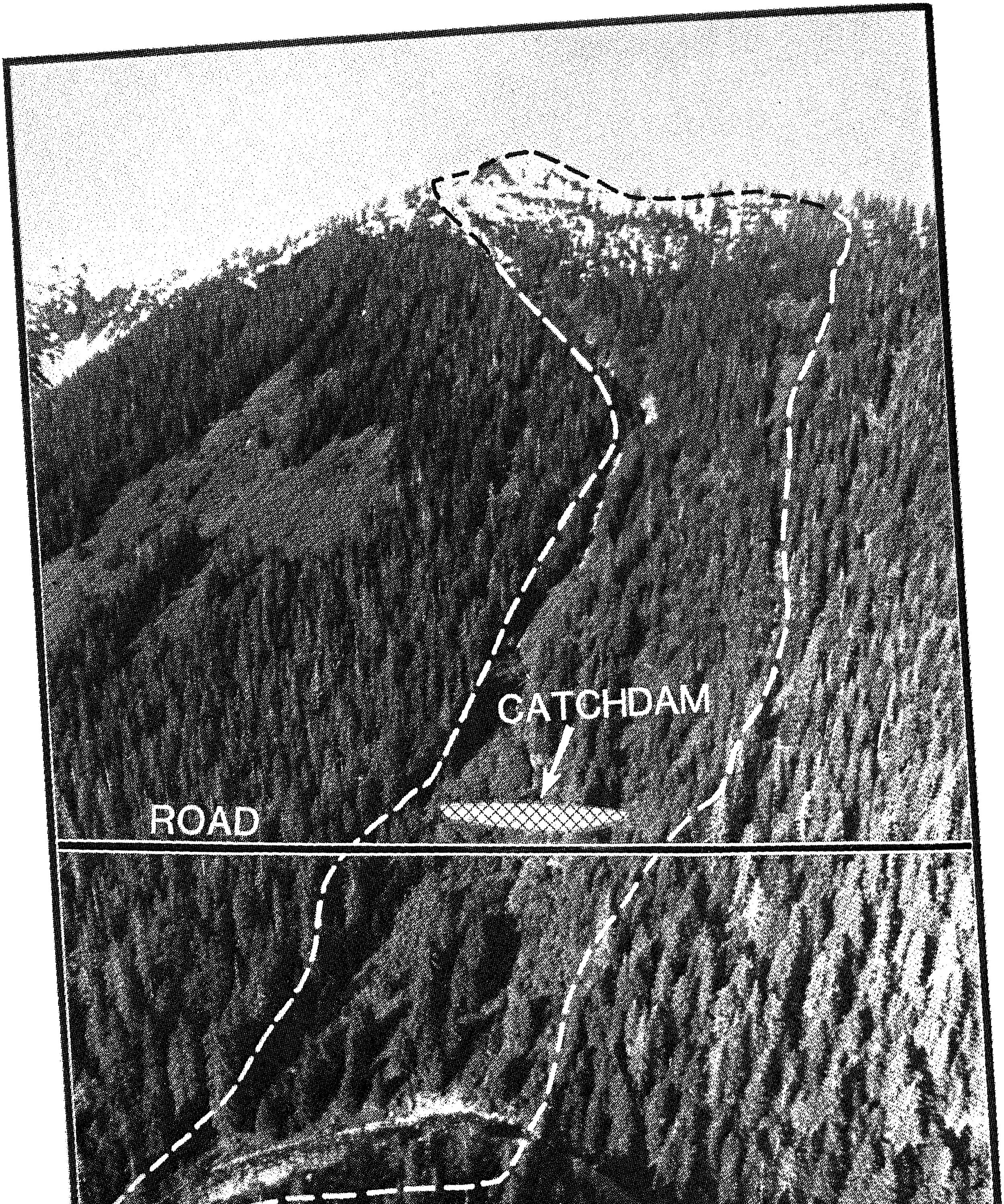
SECTION OF AVALANCHE PATH K-4



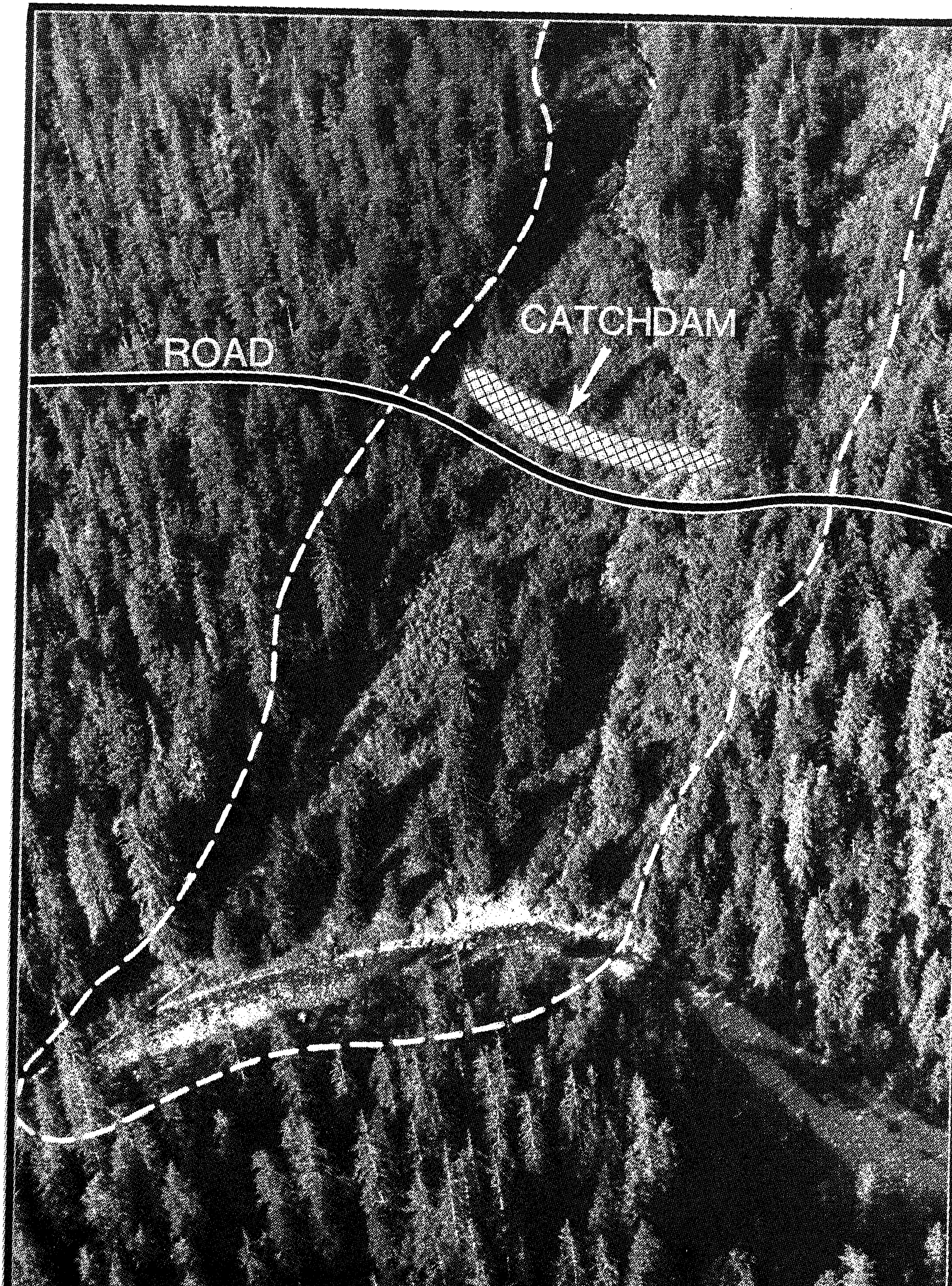
OVERVIEW OF AVALANCHE PATH K-5



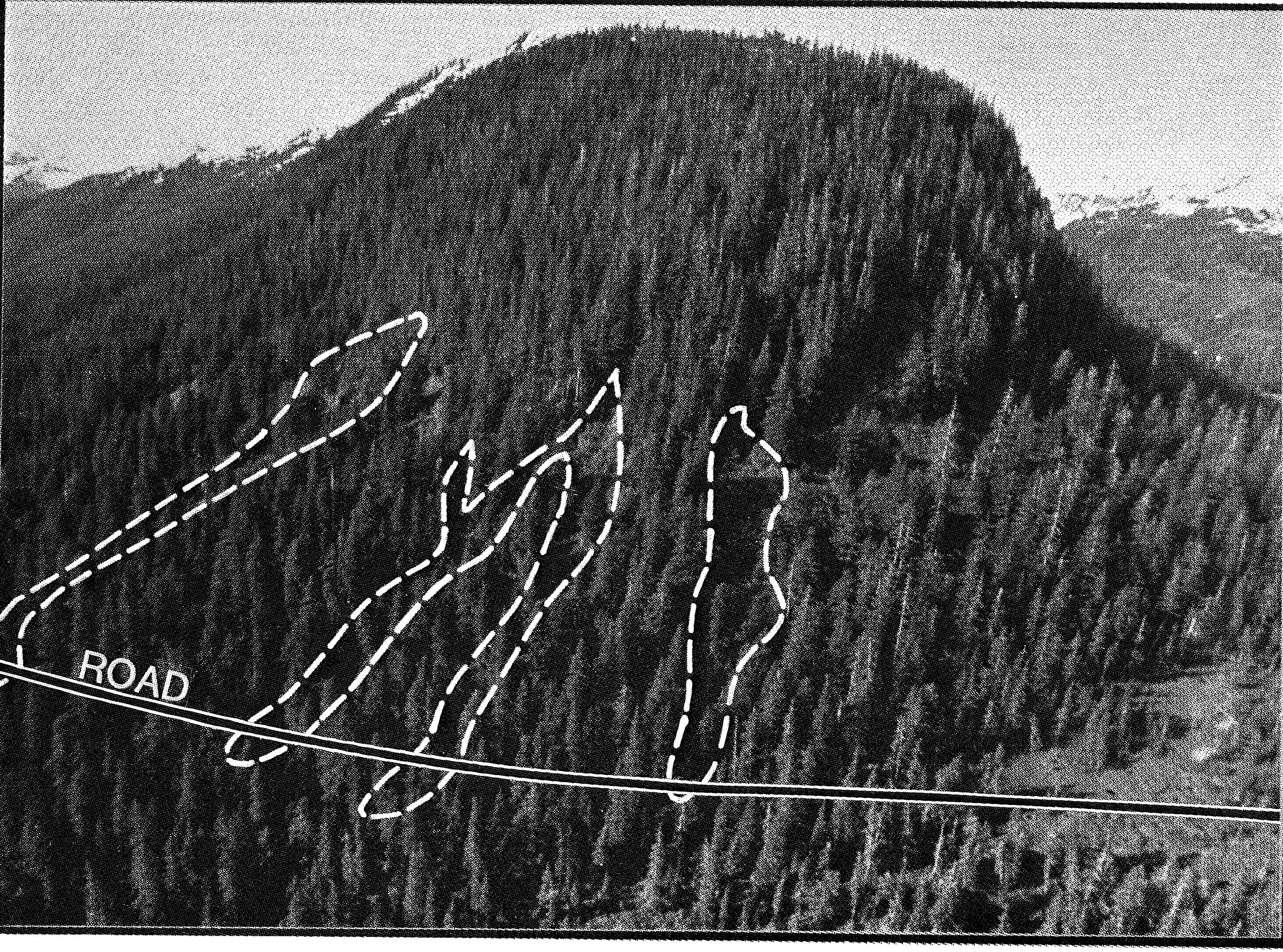
SECTION OF AVALANCHE PATH K-5



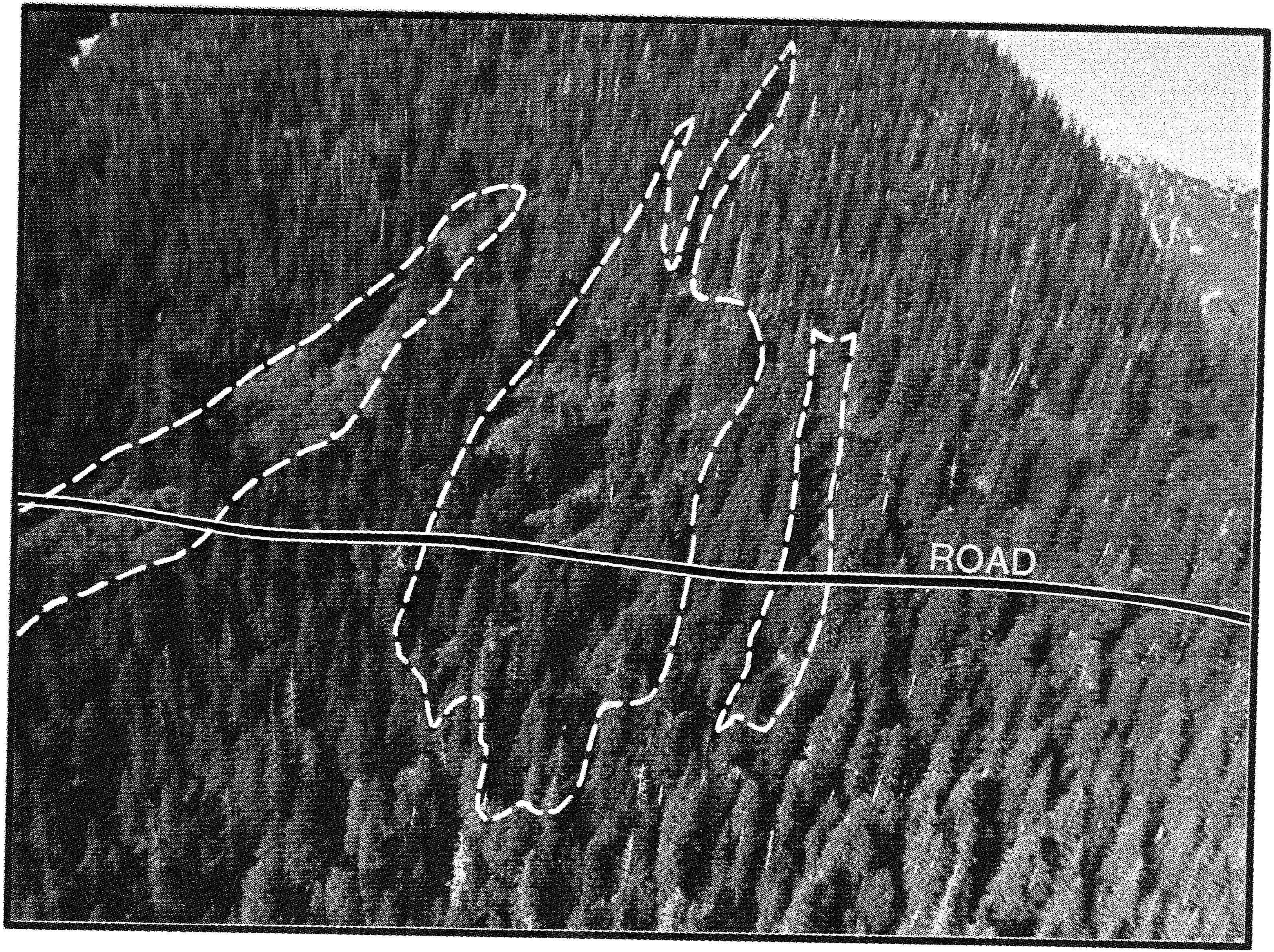
OVERVIEW OF AVALANCHE PATH K-6



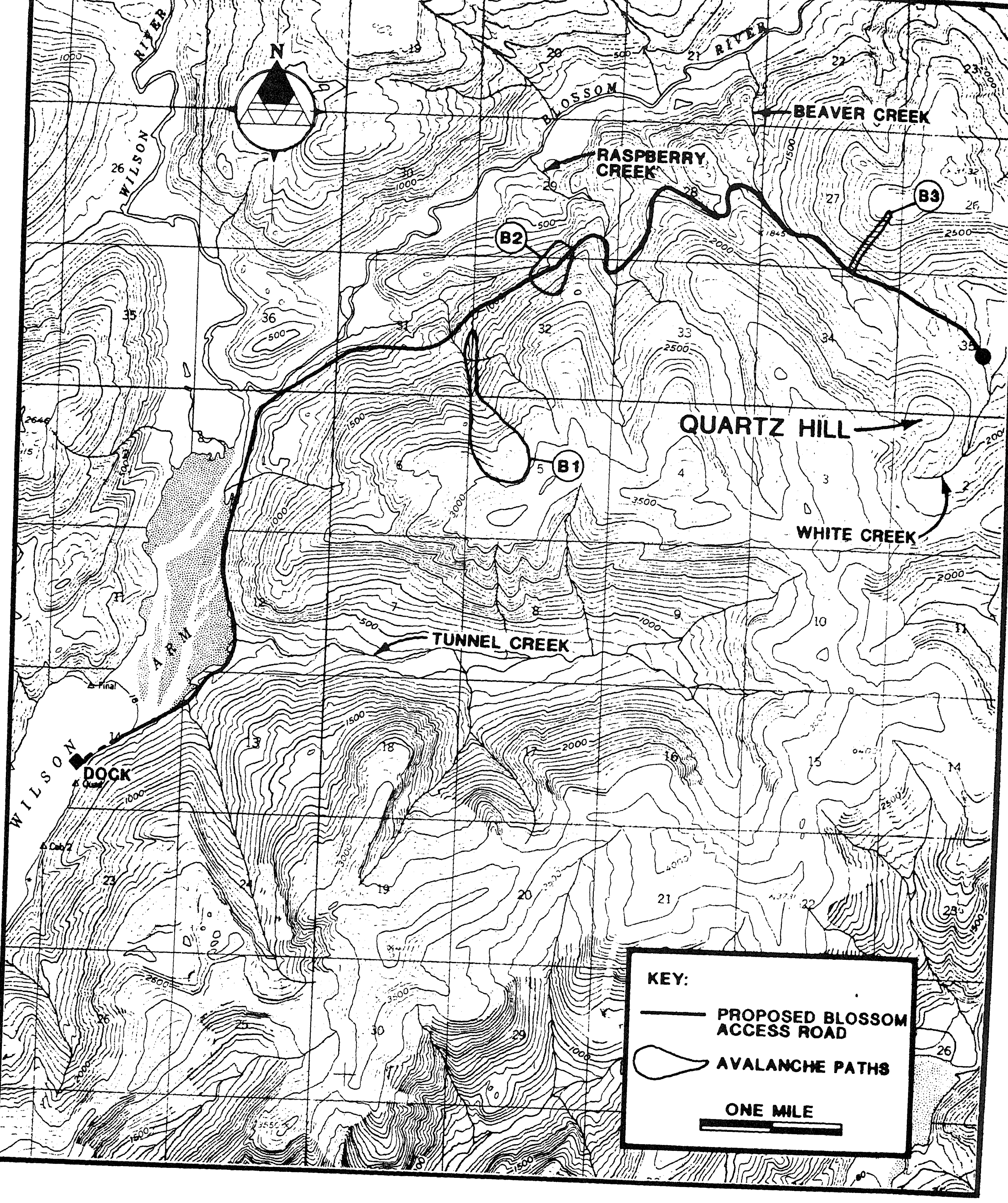
SECTION OF AVALANCHE PATH K-6



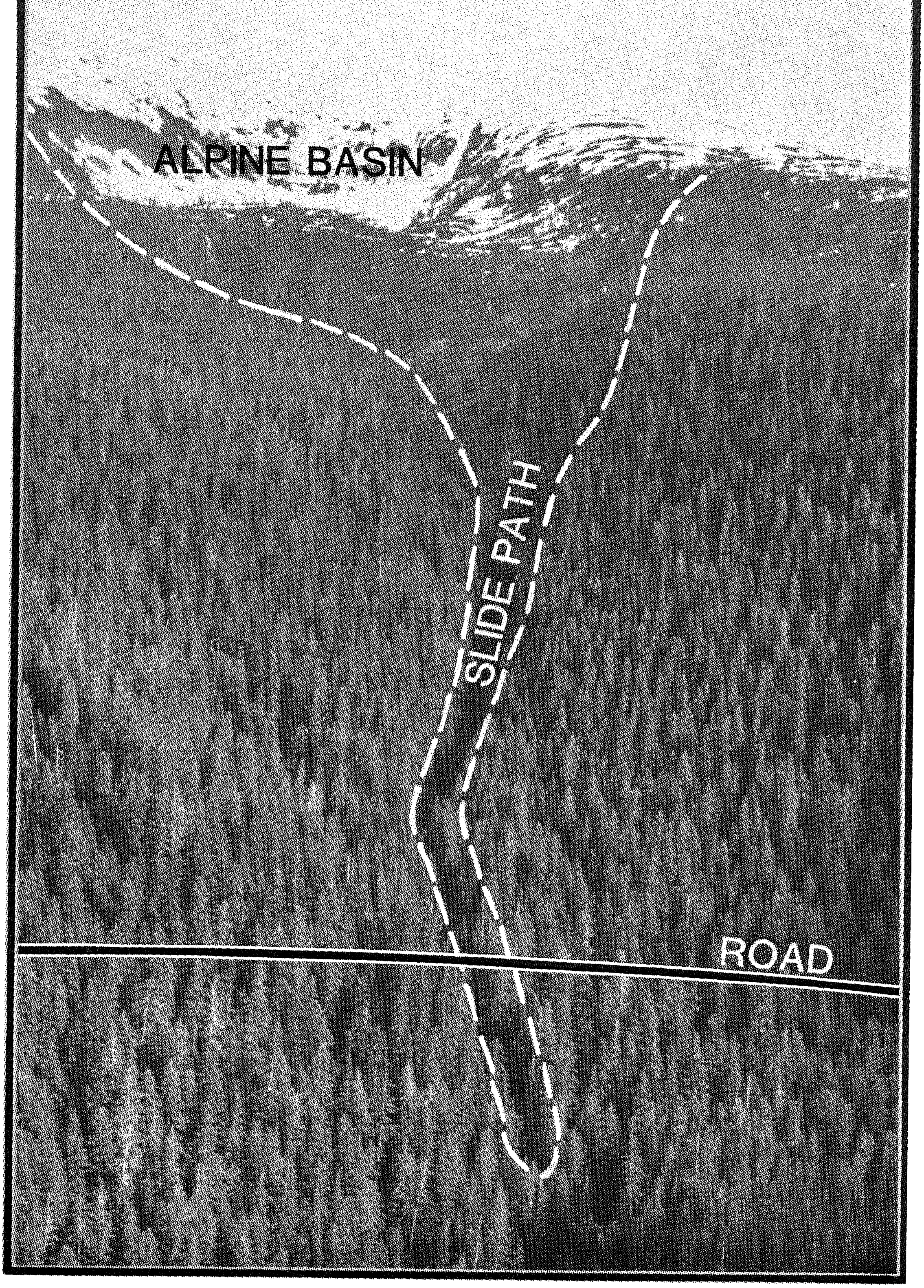
OVERVIEW OF AVALANCHE PATH K–7



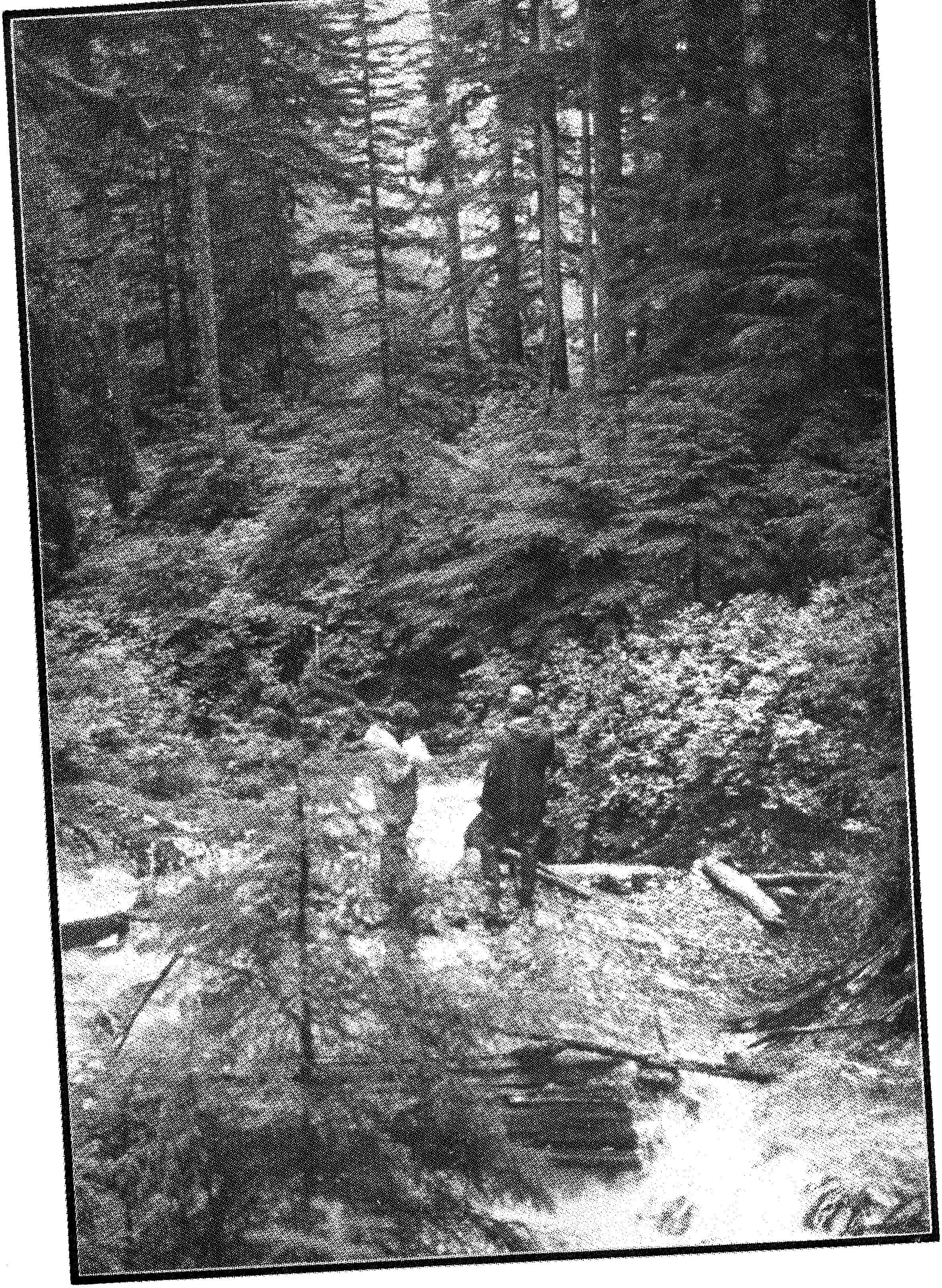
SECTION OF AVALANCHE PATH K-7



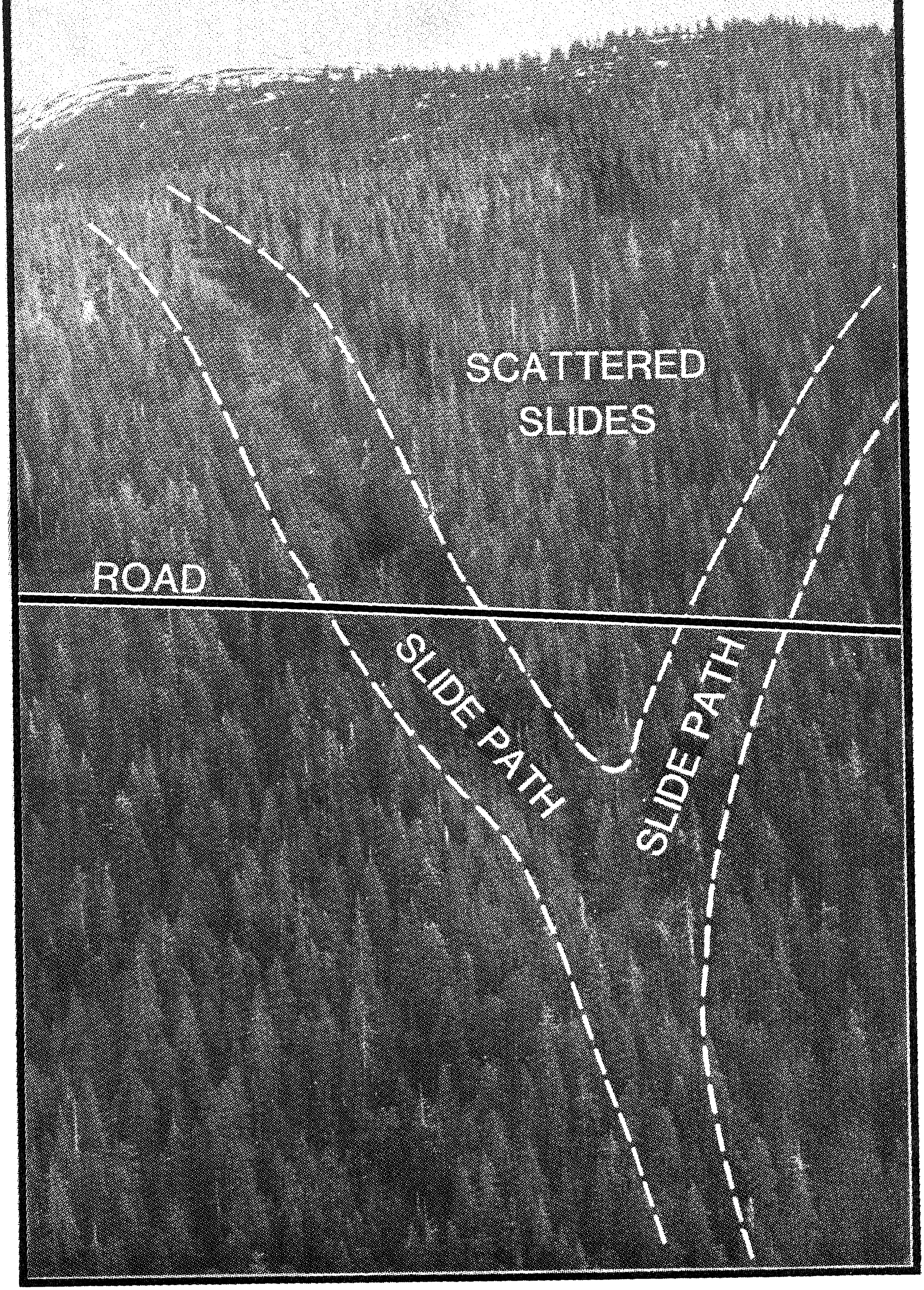
QUARTZ HILL ACCESS ROAD
BLOSSOM ROUTE



OVERVIEW OF AVALANCHE PATH B-1



BOTTOM OF AVALANCHE PATH B-1



OVERVIEW OF AVALANCHE PATH B-2

REFERENCES

Wilson, N.A., 1978. Quartz Hill avalanche study - preliminary report. Prepared for U.S. Borax and Chemical Co. Snow Consultant Services, Norden, Calif.

______, 1979. Snow, avalanche studies at Quartz Hill. Winter report - 1978-1979. Snow Consultant Services, Norden, Calif.

______, 1980. Snow avalanche studies at Quartz Hill. A summary 1978 - 1980. Snow Consultant Services, Norden, Calif.

APPENDIX D

VISUAL IMPACTS

VISUAL IMPACTS OF BORAX MINE ACCESS ROUTES AND ASSOCIATED FACILITIES

A. ENVIRONMENTAL SETTING

1. Scenic Quality

The Wilson Arm - Smeaton Bay and Boca de Quadra area is located in the central portion of the Misty Fiords National Monument. It is south of the recognized scenic areas around Walker Cove and Rudyerd Bay.

The landscapes around these bays are generally representative of those most commonly present in the Monument.

The National Forest visual resource inventory system provides a means for evaluating the scenic quality of an area. It rates the landscape quality based on the degree of diversity in its various components - landform, rock form, vegetation and water features. However, a frame of reference against which to judge these physical features is first established. This is called a character type. It is an area of land within a larger region that has a set of common physical characteristics which generally make it distinctly different from another area.

Southeast Alaska is divided into five character types. Misty Fiords is almost entirely within the mainland Coast Range character type. The coast range is characterized by massive rugged landforms, elevations ranging between 4,000 and 8,000 feet, long meandering river systems and extensive areas of bare rock and ice.

The Smeaton Bay - Wilson Arm and Boca de Quadra landscapes have an average degree of landscape diversity relative to the entire coast range. There are not the rugged terrain, diverse rock forms, diverse vegetative patterns or numerous water features that are found in the Walker Cove - Rudyerd Bay area. Slopes along these long narrow bays are steep with some terrain diversity and uniformly forested with scattered rock outcroppings. The ridgelines are long, and flat to rounded in form. Alpine area along these ridges with a few exceptions do not exhibit any striking vegetative patterns, rock forms or other features.

Under the visual resource management system most of this area would rate a variety class B since the diversity of the various landscape elements is common to the coast range character type. See the USDA handbook National Forest Landscape Management, Vol. 2, Chapter 1, "The Visual Management System" and the Region 10 supplement "Visual

Though most of the landscape around these bays falls within a variety class B, there are differences between the Smeaton - Wilson and Boca de Quadra landscapes which should be noted.

a. Smeaton Bay - Wilson Arm

At the mouth of Smeaton Bay the relief is low with elevations ranging from 500 to 1500 feet. There is a uniform forest cover with little terrain or vegetation diversity. (See Panorama A). As one moves into the bay the slopes become steeper and the terrain more broken, elevations higher, and alpine ridges more prominent. (Panorama D). At the head of the bay the landscape broadens out. The extensive tide flat and the two major river valleys that converge at the head of the tide flat gives this spaciousness to the area. (See panorama H and J). The Tunnel Creek drainage which extends off the east side of the head of Wilson Arm adds some diversity to the landscape character of this bay. The steep forested side slopes of this symmetrical U-shaped valley framing the rock faces and vegetative patterns of the ridge at the head of this creek create one of the more dramatic scenic features of the area. (Panoramas G and K). The other major scenic feature in the Wilson area that could be impacted by the mine development is the steep, rugged terrain around the head of Bakewell Arm. (See panorama M and N).

b. Boca de Quadra

This bay is much longer than the Smeaton - Wilsom Arm. Most of the length of this water body is bordered by extremely steep forested slopes. Throughout much of the length of this bay the terrain is broken by pronounced drainages and V-notches. Diverse rock forms are fairly prominent along these slopes primarily in the middle portion of this bay. Along the section about 10 miles south of the head Boca de Quadra are some extremely rugged and diverse rock forms and terrain features. This area would be rated a variety class A. Around the head of this bay though the slopes become more uniform and rock outcroppings less frequent.

The Keta River is the only major drainage flowing into the head of this bay and its valley is in direct alignment with the space formed by slopes bordering Boca de Quadra, (Panorama S and T). Hence there is not the degree of spatial diversity at the head of this inlet that there is in Wilson Arm. The tide flat at the head of Boca de Quadra is also not as extensive and diverse as the one in the Wilson. Boca de Quadra also has no side drainages quite as dramatic as the Tunnel Creek valley off the Wilson Arm. (Panorama G and S). These factors all combine to give the head of Bocade Quadra a somwehat lesser degree of

c. Summary of Scenic Quality Ratings in Project Area

The variety class throughout most of the study area is a B wi the exception of the "A" landscape mentioned above and the entrance to Smeaton Bay. The latter area is a "C" landscape because of its low relief, uniform slopes and vegetative cove and minimal landscape diversity.

2. Sensitivity Levels

While the first part of the visual inventory rates the landscapes sensitivity in terms of its inherent scenic quality the second par of the inventory assesses it sensitivity in terms of people use - sees it, how many see it, and what they see. Three sensitivity levels are established to rate these latter factors. These levels are assigned to travel routes and use areas - i.e. places from whe people view a landscape. See the USDA visual resource management handbook mentioned previously and the Region 10 sensitivity level guidelines for a complete discussion of this subject.

Under National Forest and Region 10 guidelines all officially classified areas such as wilderness would be considered the highes sensitivity level - Level I. Therefore the entire land area and a waterbodies within the Misty Fiords National Monument wilderness would be considered the designated level I use area. In the case the non-wilderness area around Wilson Arm and Boca de Quadra the level I use areas or travel routes are confined to the saltwater bodies and significant lakes, important air routes and all trails.

Smeaton Bay, Wilson Arm, Bakewell and Boca de Quadra would be the prime saltwater use areas. These use areas extend a short distanc up the Wilson, Blossom and Keta Rivers. The trail from Bakewell A to Bakewell Lake is also a level I.

An additional signficiant travel route is the air route leading to the two Forest Service cabins on Wilson Lake. On days when the ceilings are too low to allow flights over the Punchbowl Lake and Goat Lake area the Wilson Arm and Wison River valley is the alternative route to these cabins.

These use areas are designated on the accompanying visual resource map.

After identifying use areas the next inventory step is to map the land masses seen from these locations. These are also shown on th map. Additional land areas seen only from a plane are delineated

3. Visual Quality Objectives

Since the scenic quality for the area is rated a variety class the use areas rated a sensitivity level I, the recommended or inventoried visual quality objectives would be retention in th foreground and partial retention in the middleground as seen f these designated use areas.

The visual quality objectives are also identified on the visua resource map. The following briefly describes visual quality objectives:

Visual Quality Objectives - These are measurable standards or objectives for the visual management of National Forest lands. objective describes a different degree of acceptable alteratio the natural landscape based on the inherent scenic quality of landscape and the public concern for the scenic quality of tha landscape.

Preservation - To meet this objective, normally no management activities other than very low visual impact recreation facili are permitted. It allows for ecological changes only.

Retention - To meet the retention objective management alterat the landscape can take place but must not be evident to the ex that they change the natural character of the landscape by introducing different forms, lines, colors or textures. To me objective a road across a forested slope, including the vegeta clearing, the road bed, and any road cuts or fills cannot be e

Partial Retention - To meet this objective a management activi be evident but any new forms, lines, colors, or textures intro by the activity must be small enough so as not to dominate the natural characteristics of the landscape. For example, a road a slope can be visible but only for short, infrequent segments and fill slopes should be minimal, or if present, completely revegetated and contoured to blend with the natural terrain.

Modification - Under this objective management activities may dominate the original characterisitics landscape. However, activities should borrow from natural forms, lines, colors and textures so completely that its visual characteristics are tho

natural occurrences in the surrounding area. A road corridor in thi case could be highly visible but must follow the natural contours. All cut and fill slopes should be thoroughly revegetated with the plant materials natural to the surrounding area. Large rock cuts ou of scale with natural rock out croppings immediately around the corridor should not be visible.

Maximum Modification - To meet this objective management activities can clearly dominate the natural landscape. From nearby viewing positons the activity may not relate to natural elements of the landscape, but when viewed from greater distances (generally over five miles) the visual elements of the activity should blend somewha with the natural landscape. In this case road cuts and fills and vegetative clearing might be clearly visible from a few miles but should relate to natural features such as rock outcrops, ridge line beach lines and vegetative patterns, etc., when viewed from distant viewing positions.

Unacceptable Modification - This term defines activities which are large in scale and which have visual elements contrasting so much with natural features that the activity in no way relates to the original characteristic landscape from any viewing distance.

See National Forest Landscape Management, Volume 2, Chapter 1 "The Visual Management System: for a more detailed discussion of visual quality objectives.

B. PROPOSED FACILITIES ASSOCIATED WITH BORAX MINE AND VISUAL IMPACTS

1. Facilities associated with Blossom River Access Route and Their Visual Impacts.

The access road would begin from a port facility about a mile south of the mouth of Tunnel Creek. It would run along the beach to the head of the Wilson tide flat then start climbing as it goes up the Blossom Valley. The overall road width would be about 36 feet and places 10 feet wider to accommodate a utility corridor. The road would begin at a dock and staging area at least 15 acres large.

Possible townsites connected to the Blossom access route include an area around a knoll between the Blossom and Wilson rivers, the top o a long ridge a couple of miles up the Blossom drainage, and an area near the head of Bakewell Arm.

If the land disposal alternative was chosen for mine tailings it would be in the Tunnel Creek valley and Aronitz Creek valley in Boca de Quadra. It would fill the length of these valleys and require a dam about 750 feet high.

The other major facility whose location is affected by the access route is the ore processing plant. For the Blossom it would be located on a knoll about four miles up the river overlooking the confluence of the main channel and one of its tributaries.

Visual Impacts of Blossom Route

The major impact would be from the road and port facility. A 36 foot roadway immediately along the shore would probably involve fill out onto the tidal area particularly between Tunnel Creek and the head of the Wilson tide flats where cliffs drop right to saltwater in many areas, restricting the location of the road. The width of the road and the required loads it must carry would necessitate a very substantial road bed creating fairly high fill banks. Substantial cut banks into the steep slopes and vertical cliffs will be quite prominent. The overall result would be a strong horizontal line introduced into the natural landscape. Such a line would be much more dominant than the existing line created by the natural shoreline

The configuration of the upper end of Wilson Arm is such that from most viewing positonson saltwater as well as on the tide flats one would look directly at this highly visible line. This road would particularly impact the integrity of the dramatic view into the Tunnel Creek valley unless the road is routed behind the large Spruce on the beach.

An enormous impact would be created by a tailings disposal in the Tunnel Creek valley off the Wilson Arm and in the Aronitz Creek valley off Boca de Quadra. A dam in Tunnel Creek would obliterate the view to the head of the valley, and because of its straight horizontal line and massive, uniform, gray face, would totally dominate much of the of Wilson Arm landscape.

The dock and staging area would involve clearing an area about 15 acres about a mile south of Tunnel Creek. The resulting high rock walls, the docking area necessary to accomodate the large ore ships, the extensive equipment and vehicles necessary to handle the ore and the large amount of equipment and material stored in the area combine to produce a major activity that will clearly dominate the natural landscape.

A townsite located between the Blossom and Wilson drainages could create an additional visual impact if the site development involved leveling the top of the knoll that screens some of this site. This would create a landform that would dominate the otherwise gently rounded forms. A site on the narrow ridge upstream from the mouth

would not be visible from saltwater. A site in Bakewell Arm would b clearly evident from the water, but the terrain, orientation of this site and its size is such that some mitigation of impacts might be possible. However, a road connecting the Bakewell site to the mine along the steep slopes of Bakewell and Wilson Arms would have very high visual impacts.

The ore processing plant would not be visible from saltwater but would be from the air. The open pit mine would not be visible from saltwater or any key air routes.

The overall visual impact of all these facilities from saltwater not including a land tailings disposal, would only meet maximum modification. These facilities, at least from foreground and middlegournd viewing positions, would clearly dominate the natural landscape since the lines forms and textures would not at all be consistent with those of the natural landscape. From background viewing positions on saltwater, i.e. positions 5 miles or greater down from the head of Wilson Arm, this road may start to blend into the natural shoreline.

From the air route up the Wilson Arm and Wilson River most of the access road would be visible including the portion crossing the extremely steep slopes along the Blossom drainage. This stretch wi possesses numerous massive cut and fill slopes. The plant site wil also be visible from this route as will the entire townsite development. The overall impact would be unacceptable modification in that the overall scale and form of the activities in no way rela to the natural occurrences in the landscape.

The addition of a tailings disposal dam on Tunnel Creek and Aronitz Creek in Boca de Quadra would create an unacceptable modification o the natural landscape from both saltwater and aerial viewing positions.

The open pit mine would also be an unacceptable modification of the landscape as viewed from an area over the Hill Creek or North Meado areas.

2. Proposed Facilities Associated with Keta River Route and Visual. Impacts

The Keta River access route would start at a port facility just sou of Aronitz Creek, would hug the shoreline along the tide flats brid the Keta River just above its mouth and then follow the northwest side of the Keta valley staying in or near its floodplain for a few miles before gaining elevation.

The port facility would be similar in scale and concept to that planned for the Blossom side.

A townsite for the Boca de Quadra option would be on the large spruce flats on either side of the river.

If land disposal of tailings is chosen in Boca de Quadra it would also involve both the Tunnel Creek and Aronitz Creek valleys.

The plant site for the Keta option would be in the North Meadow area northeast of the mine pit.

Visual Impacts of Keta Route and Associated Facilities

The access road as in the Blossom option hugs the shore with its alignment severely restricted by steep slopes and cliffs. From saltwater viewing positions south of the tide flats and Aronitz Creek the section between the port facility and Aronitz Creek will be highly visible. However, the section along the tide flats, though clearly evident will be viewed from these same positions at a sharply oblique angle. Generally not as much of the Keta road will be directly visible from as many viewing positions as a road along the Blossom route.

The port facility will have the same major impacts as a port facility located on Wilson Arm.

A townsite located along the Keta River would not have major impacts as seen from saltwater if some of the Spruce along the back of the tide flats were preserved.

The land tailings disposal areas for the Keta option would be, as with the Blossom route option, both the Tunnel and Aronitz Creek valleys. Hence if land disposal was chosen the impacts from this activity would be the same for the Blossom and Keta routes.

Impacts from the air are not as critical since no frequently used air routes exist in the upper part of Boca de Quadra or along the Keta River valley.

Though the overall impact is somewhat less in Boca de Quadra because of the configuration of the bay, the type and size of activities proposed is virtually the same in this bay as in the Wilson Arm. Hence from many vantage points near the head of bay the impact of the road and port facility would be similar to that in Wilson Arm meeting no more than the maximum modification visual quality objective.

C. SUMMARY COMPARISON OF VISUAL IMPACTS OF KETA AND BLOSSOM ROUTES

Overall the visual impacts of a Blossom access route would be greater than a Keta route for the following reasons:

1. The scenic quality is greater near the head of Wilson Arm than at the head of Boca de Quadra.

2. The different configuration of the two bays cause the saltwater area impacted to be larger in the Wilson Arm than in Boca de Quadra.

3. There is the additional impact as viewed from air routes over the Wilson Arm and River. The impact to air routes is not as significant in Boca de Quadra.

4. There is potential for high visual impact in Bakewell Arm from possible townsite and access to it.

D. POSSIBLE MITIGATING MEASURES

The following is a list of steps that could be taken with respect to the different activities that might significantly reduce the visual impacts.

1. Road construction

   a. Any road cuts exposing rock faces could be done in a way that would create series of ledges or benches that could provide planting pockets for small seedlings, grass or alder. Over time these exposed rock faces would tend to mimic the natural rock faces such as seen in Panorama R an T.

   b. Cover rock fill slopes along shoreline with overburden and plant shrubs, alder or conifer seedlings.

   c. Seeding of all other cut and fill slopes.

   d. Clean up of all r.o.w. clearing slash and loose rock created by rock cuts.

   e. Incorporating tailings pipeline in road shoulders to minimize width of road clearing as mentioned in Concepts Analysis Document.

2. Road alignment

   a. Locate road back from beach where it crosses Tunnel Creek flats or Aronitz Creek flats.

3. Townsite or campsite development

   a. Before clearcutting entire site consider what stands of old growth might be preserved that would fit general town layout concept and that might be wind firm.

   b. Consolidate development - consider using clustering concept.

   c. Any reshaping of natural terrain such as knoll between Blossom and Wilson Rivers should be done in a way that mimics surrounding natural lines and forms.

   d. Use natural materials for structures.

   e. Develop a plan to revegetate site.

4. Port Facility

   a. Minimize scale of development at dock site by utilizing flat behind mouth of Tunnel Creek or Aronitz Creek.

   b. Complete cleanup of all slash and loose rock debris.

E. PROPOSED PHOTOPOINTS FOR MONITORING

To monitor the visual impacts of the mine development activities as they take place over the next several years several photopoints have been established. From these key viewing positions photopanoramas have been taken of the landscape as it now appears in its natural, pristine state. In this way an assessment can be made of how development activities over time change the natural character of these landscapes.

These photopoints have been selected based on several criteria.

They generally are locations from where people are most likely to view these landscapes, that afford the optimum views of the total landscape, locations from which the development impacts are greatest, and locations from which one has the best view of the most scenic and dramatic landscapes.

Included among these points are a few saltwater viewing positions in each bay and positions near the mouth of the respective rivers. These photopoints are included in the panoramas that are a part of this report and are identified as such.

Additional photopoints from aerial viewing positions should also be identified and recorded to reflect air routes in the area, particularly those over the Wilson Arm and Wilson River drainage. From these air routes one gets a full view of most of the mine development activities proposed in this drainage except for the mine pit itself.

Aerial photopoints will also be established from positions over the North Creek and/or Hill Creek drainages where one gets a full view of the mine.

As each stage of development proceeds photo panoramas will be taken from these same points to record how the natural landscape has been altered by these activities, and specifically how proposed mitigating measures have achieved certain objectives.

Each photopoint will be individually recorded and keyed to a topo map that displays the seen area from this point. Proposed activities can be graphically portrayed on the photo panoramas to help predict the future impacts. Space will be provided to record future panoramas from this same point that will allow comparisons between the natural undeveloped landscape and that same area at different stages of development.

John Short

JOHN SHORT
Landscape Architect

September 29, 1981

453L

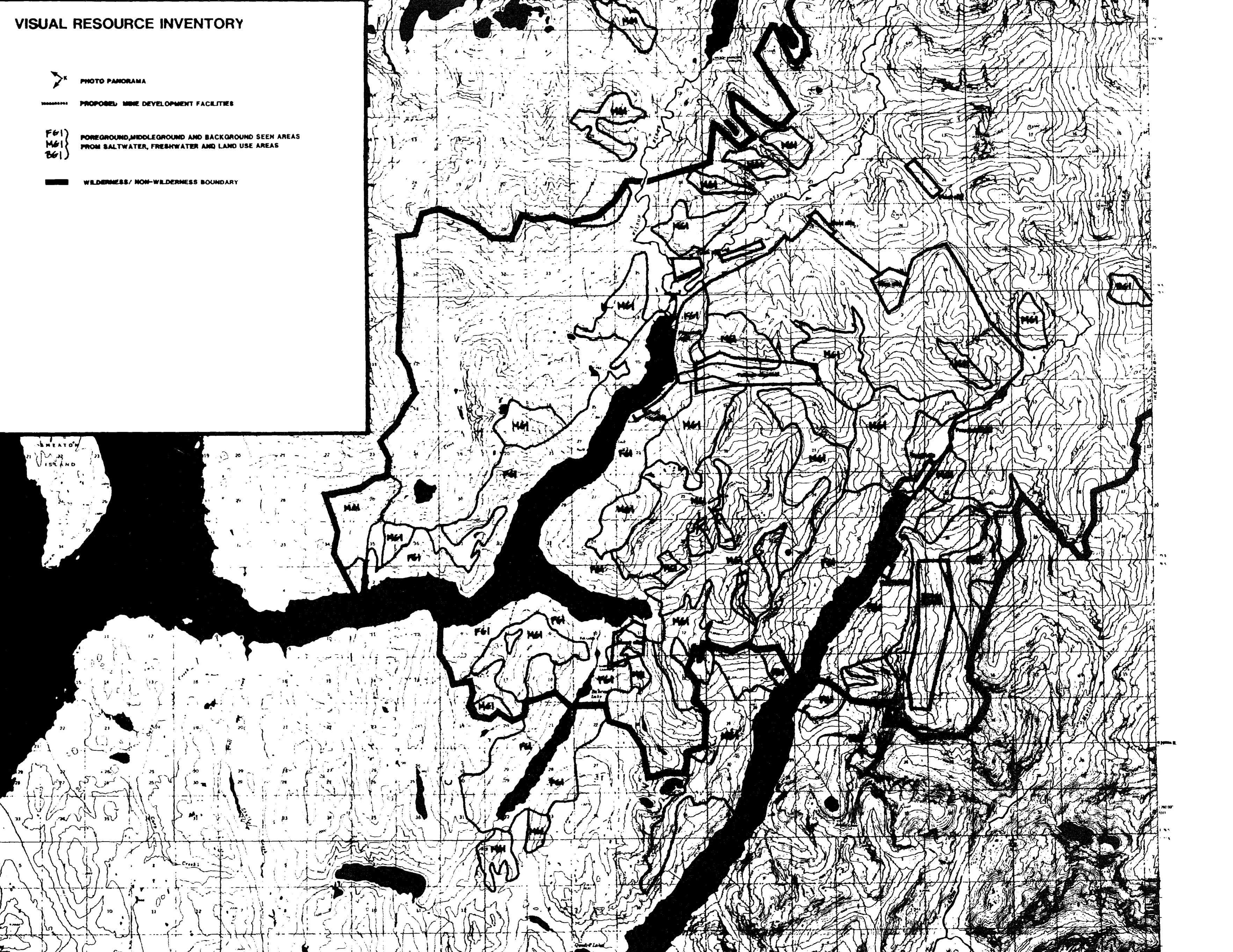
VISUAL RESOURCE INVENTORY

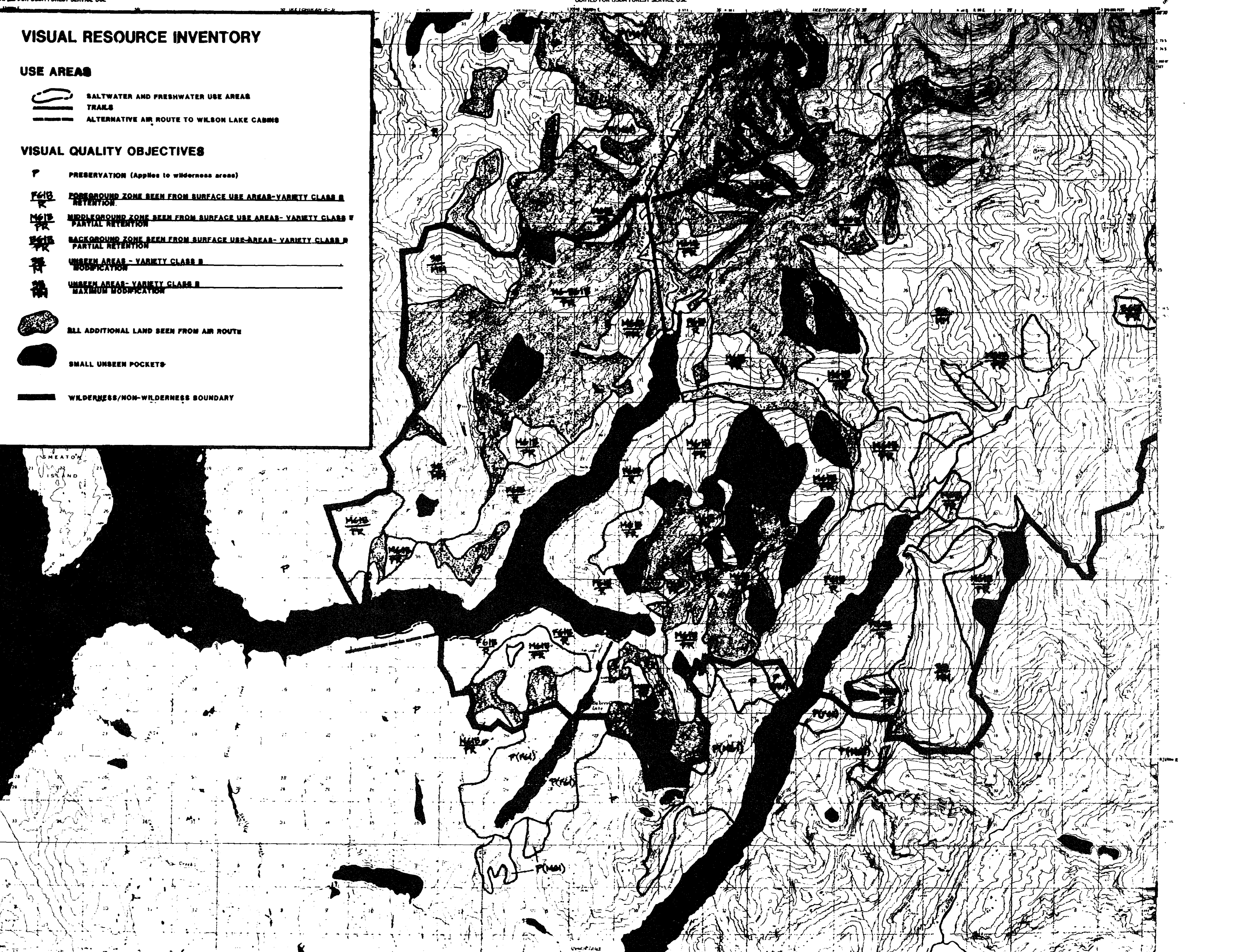
PHOTO PANORAMA

PROPOSED MINE DEVELOPMENT FACILITIES

FG1 MG1 BG1 FOREGROUND, MIDDLEGROUND AND BACKGROUND SEEN AREAS FROM SALTWATER, FRESHWATER AND LAND USE AREAS

WILDERNESS/ NON-WILDERNESS BOUNDARY





VISUAL RESOURCE INVENTORY
USE AREAS
SALTWATER AND FRESHWATER USE AREAS
TRAILS
ALTERNATIVE AIR ROUTE TO WILSON LAKE CABINS
VISUAL QUALITY OBJECTIVES
P PRESERVATION (Applies to wilderness areas)
FOREGROUND ZONE SEEN FROM SURFACE USE AREAS-VARIETY CLASS B RETENTION
MIDDLEGROUND ZONE SEEN FROM SURFACE USE AREAS- VARIETY CLASS B PARTIAL RETENTION
BACKGROUND ZONE SEEN FROM SURFACE USE AREAS- VARIETY CLASS B PARTIAL RETENTION
UNSEEN AREAS - VARIETY CLASS B MODIFICATION
UNSEEN AREAS- VARIETY CLASS B MAXIMUM MODIFICATION
ALL ADDITIONAL LAND SEEN FROM AIR ROUTE
SMALL UNSEEN POCKETS
WILDERNESS/NON-WILDERNESS BOUNDARY
SMEATON ISLAND
KETCHIKAN C-3
KETCHIKAN B-3

APPENDIX E

ALASKA NATIONAL INTEREST LANDS
CONSERVATION ACT,
Sections 503, 405 and 505

MISTY FJORDS AND ADMIRALTY ISLAND NATIONAL MONUMENTS

16 USC 431 note.

SEC. 503. (a) There is hereby established within the Tongass National Forest, the Misty Fjords National Monument, containing approximately two million two hundred and eighty-five thousand acres of public lands as generally depicted on a map entitled "Misty Fjords National Monument-Proposed", dated July 1980.

16 USC 431 note.

(b) There is hereby established within the Tongass National Forest, the Admiralty Island National Monument, containing approximately nine hundred and twenty-one thousand acres of public lands as generally depicted on a map entitled "Admiralty Island National Monument-Proposed", dated July 1980.

Management by Agriculture Secretary.

(c) Subject to valid existing rights and except as provided in this section, the National Forest Monuments (hereinafter in this section referred to as the "Monuments") shall be managed by the Secretary of Agriculture as units of the National Forest System to protect objects of ecological, cultural, geological, historical, prehistorical, and scientific interest.

(d) Within the Monuments, the Secretary shall not permit the sale of harvesting of timber: Provided, That nothing in this subsection shall prevent the Secretary form taking measures as may be necessary in the control of fire, insects, and disease.

Post, 2457.

(e) For the purposes of granting rights-of-way to occupy, use or traverse public land within the Monuments pursuant to title XI, the provisions of section 1106(b) of this Act shall apply.

(f)(1) Subject to valid existing rights and the provisions of this Act, the lands within the Monuments are hereby withdrawn from all forms of entry or appropriation or disposal under the public land laws, including location, entry, and patent under United States mining laws, disposition under the mineral leasing laws, and from future selections by the State of Alaska and Native Corporations;

Valid mining claims.

(2)(A) After the date of enactment of this Act, any person who is the holder of any valid mining claim on public lands located within the boundaries of the Monuments, shall be permitted to carry out activities related to the exercise of rights under such claim in accordance with reasonable regulations promulgated by the Secretary to assure that such activities are compatible, to the maximum extent feasible, with the purposes for which the Monuments were established.

(B) For purposes of determining the validity of a mining claim containing a sufficient quantity and quality of mineral as of November 30, 1978, to establish a valuable deposit within the meaning of the mining laws of the United States within the Monuments, the requirements of the mining laws of the United States shall be construed as if access and mill site rights associated with such claim allow the present use of the Monuments' land as such land could have been used on November 30, 1978.

90 Stat. 1342.

(g) MINING IN THE PARKS ACT.-The Act of September 28, 1976 (Public Law 94-249), shall not apply to the Monuments.

(h)(1) Any special use permit for a surface access road for bulk sampling of the mineral deposit at Quartz hill in the Tongass National Forest shall be issued in accordance with this subsection.

Mining development analysis document.

(2) The Secretary of Agriculture, in consultation with the Secretaries of Commerce and the Interior and the State of Alaska, shall prepare a document which analyzes mine development, concepts prepared by United States Borax and Chemical Corporation on the proposed development of a molybdenum mine in the Quartz Hill area of the Tongass National Forest. The draft of such document shall be completed within six months after the date of enactment of this Act and be made available for public comment. The analysis shall be completed within nine months after the date of enactment and the results made available to

Public availability.

the public. This analysis shall include detailed discussions of but not necessarily be limited to-

(A) the concepts which are under consideration for mine development;

(B) the general foreseeable potential environmental impacts of each mine development concept and the studies which are likely to be needed to evaluate and otherwise address those impacts; and

(C) the likely surface access needs and routes for each mine development concept.

onmental impact atement. JSC 4321 note.

(3) The Secretary shall prepare an environmental impact statement (EIS) under the National Environmental Policy Act of 1969 which covers an access road for bulk sampling purposes and the bulk sampling phase proposed by United States Borax and Chemical Corporation in the Quartz Hill area. A draft of such EIS shall be completed within twelve months after the date of enactment of this Act. This EIS shall incorporate all relevant data and other information included in the EIS previously prepared by the Secretary on access to the Quartz Hill area. Such EIS shall also include but not necessarily be limited to-

(A) an evaluation of alternative surface access routes which may minimize the overall impact on fisheries of both access for bulk sampling and mine development access;

(B) an evaluation of the impacts of the alternatives on fish, wildlife, and their habitats, and measures which may be instituted to avoid or minimize negative impacts and to enhance positive impacts;

(C) an evaluation of the extent to which the alternatives can be used for, and the likelihood of each alternative being used as a mine development road, including the impacts of widening a road, realinements and other design and placement options; and

(D) plans to evaluate the water quality and water quantity, fishery habitat, and other fishery values of the affected area, and to evaluate, to the maximum extent feasible and relevant, the sensitivity to environmental degradation from activities carried out under a plan of operations of the fishery habitat as it affects the various life stages of anadromous fish and other foodfish and their major food chain components.

ministrative review.

(4)(A) Within four months after the publication of the final environmental impact statement required in subsection (h)(3), the Secretary shall complete any administrative review of a decision on the proposal covered by the EIS and shall issue to the applicant a special use permit for a surface access road for bulk sampling unless he shall determine that construction or use of such a road would cause an unreasonable risk of significant irreparable damage to the habitats of viable populations of fish management indicator species and the continued productivity of such habitats. If the applicant should seek judicial review of any denial of the permit for a surface access road, the burden of proof on the issue of denying the permit shall be on the Secretary.

(B) The Secretary shall not issue a special use permit until after he has determined that the full field season of work for gathering base line data during 1981 has ended.

Judicial review.

42 USC 4321 note.

(5) It is the intent of Congress that any judicial review of any administrative action pursuant to this section, including compliance with the National Environmental Policy Act of 1969, shall be expedited to the maximum extent possible. Any proceeding before a Federal court in which an administrative action pursuant to this section, including compliance with the National Environmental Policy Act of 1969, is challenged shall be assigned for hearing and completed at the earliest possible date, and shall be expedited in every way by such court, and

such court shall render its final decision relative to any challenge within one hundred and twenty days after the date the response to such challenge is filed unless such court determines that a longer period of time is required to satisfy the requirements of the United States Constitution.

(6) Upon application of the United States Borax and Chemical Corporation or its successors in interest, the Secretary shall permit the use by such applicant of such limited areas within the Misty Fjords National Monument Wilderness as the Secretary determines to be necessary for activities, including but not limited to the installation, maintenance, and use of navigation aids, docking facilities, and staging and transfer facilities, associated with the development of the mineral deposit at Quartz Hill. Such activities shall not include mineral extraction, milling, or processing. Such activities shall be subject to reasonable regulations issued by the Secretary to protect the values of the monument wilderness.

(7) Within the Misty Fjords National Monument Wilderness the Secretary of Agriculture shall, to the extent he finds necessary, allow salvage, cleanup, or other activity related to the development of the mineral deposit at Quartz Hill, including activities necessary due to emergency conditions.

(8) Designation of section 703 of this Act of the Misty Fjords National Monument Wilderness shall not be deemed to enlarge, diminish, add, or waive any substantive or procedural requirements otherwise applicable to the use of offshore waters adjacent to the mineral deposit at Quartz Hill, including, but not limited to, navigation, access, and the disposal of mine tailings produced in connection with such development.

Mineral deposits, mining or milling leases.

(i)(1) With respect to the minerals deposits at Quartz Hill and Greens Creek in the Tongass National Forest, the holders of valid mining claims under subsection (f)(2)(B) shall be entitled to a lease (and necessary associated permits) on lands under the Secretary's jurisdiction (including lands within any conservation system unit) at fair market value for use for mining or

milling purposes in connection with the milling of minerals from such claims situated within the Monuments only if the Secretary determines-

(A) that milling activites necessary to develop such claims cannot be feasibly carried out on such claims or on other land owned by such holder;

(B) that the use of the site to be leased will not cause irreparable harm to the Misty Fjords or the Admiralty Island National Monument; and

(C) that the use of such leased area for such purposes will cause less environmental harm than the use of any other reasonably available location.

With respect to any lease issued under this subsection, the Secretary shall limit the size of the area covered by such lease to an area he determines to be adequate to carry out the milling process for the mineral bearing material on such claims.

(2) A lease under this subsection shall be subject to such reasonable terms and conditions as the Secretary deems necessary.

Lease termination.

(3) A lease under this subsection shall terminate-

(A) at such time as the mineral deposit is exhausted; or

(B) upon failure of the lessee to use the leased site for two consecutive years unless such nonuse is waived annually by the Secretary.

(j) SPECIAL USE PERMITS AND FACILITIES.-The Special Use Permit for Thayer Lake Lodge shall be renewed as necessary for the longest of either-

(1) fifteen years after the date of enactment of this Act, or

(2) the lifetime of the permittee, as designated in such permit as of January 1, 1979, or the surviving spouse or child of such permittee, whoever lives longer.

so long as the management of the lodge remains consistent with the purposes of the Admiralty Island National Monument.

UNPERFECTED MINING CLAIMS IN MISTY FJORDS AND ADMIRALTY ISLAND NATIONAL MONUMENTS

SEC. 504.(a) DEFINITIONS.-As used in this section:

(1) The term "unperfected claim" means a mining claim:

(A) which is within the Misty Fjords or Admiralty Island National Monuments;

(B) with respect to which a valid mineral discovery, within the meaning of the mining laws of the United States, was not made as of November 30, 1978; and

(C) which was, as of such date, properly located, recorded, and maintained.

(2) The term "core claim" means-

(A) a patented mining claim; or

(B) an unpatented mining claim which-

(i) contained a valid mineral discovery within the meaning of the mining laws of the United States as of November 30, 1978, and

(ii) was, as of such date, properly located, recorded, and maintained.

(b) ENTITLEMENT.-Any holder of an unperfected mining claim who meets the requirements of this section shall be entitled as provided in this section-

(1) to receive an exploration permit with respect to such claim, and

(2) to receive a patent only to the minerals upon making a valid mineral discovery on such claim within the meaning of the mining laws of the United States.

(c) EXPLORATION PERMITS.-

(1) Permits authorizing the exploration of an unperfected mining claim shall be issued by the Secretary under this section upon application under subsection (d) if the Secretary determines that-

(A) an application for such permit has been submitted within two-hundred-seventy days after the date of the enactment of this Act and such application meets the requirements of subsection (d);

(B) the unperfected claim is within three-quarters of a mile of the exterior boundary of one or more core claims, and both of the unperfected claim and core claim were held by the applicant as of May 1, 1979 (or were acquired by such applicant after such date by inheritance or devise); and

(C) the core claim and the unperfected claim which is within the area referred to in subsection (B) are properly located, recorded, and maintained, to the extent required by law, as of the date of the Secretary's determination under this subsection.

ation.

(2)(A) Each exploration permit issued under this section shall terminate on the date five years after the date of the enactment of this Act, or where applicable, the date provided under subparagraph (c)(2)(B).

(B) For any permit applicant, with repect to which the Secretary fails to meet the eighteen-month deadline under subsection (d) for any reason (including delays caused by administrative or judicial proceedings) beyond the control of the applicant, the exploration permit issued under this section shall terminate at the end of the period (after expiration of the five years referred to in subparagraph (c)(2)(A) as is equal to the time during which the Secretary failed to meet such deadline.

(3) Any permit under this section shall include such

(d) APPLICATIONS FOR EXPLORATION PERMITS.-An application under subsection (b) shall contain-

(1) the applicant's name, address, and telephone number;

(2) the name of the claim, the date of location of the claim, the date of recordation of the claim, and the serial number assigned to such claim under the Federal Land Policy and Management Act of 1976; and

(3) evidence that the requirements of subparagraphs (B) and (C) of subsection (c)(1) are met.

Upon the Secretary's determination that the requirements of subsection (c) are met with respect to any claim, the Secretary shall issue an exploration permit for such claim not later than eighteen months after the date on which he receives the application under this subsection concerning such claim.

(e) VALID MINERAL DISCOVERY.-

(1) If the holder of an unperfected mining claim for an exploration permit was issued under this section notifies the Secretary before the expiration of such permit, that he has made a valid mineral discovery within the meaning of the mining laws of the United States on such claim, and if it is determined that such claim contains a valid mineral discovery, the holder of such claim shall be entitled to the issuance of a patent only to the minerals in such claim pursuant to the mining laws of the United States, together with a right to use so much of the surface of the lands on such claim as may be necessary for mining and milling purposes, subject to such reasonable regulations as the Secretary may prescribe for general application to mining and milling activities within the National Forest System.

(2) Any unperfected claim for which an exploration permit under this section was issued shall be conclusively presumed to be abandoned and shall be void upon expiration of such permit unless the owner of such claim has notified the Secretary in writing as provided in paragraph (e)(1).

(f) LEASES FOR MILLING PURPOSES.-

(1) The Secretary may issue leases (and necessary associated permits) on lands under the jurisdiction (including lands within any conservation system unit) at fair market value for use for mining or milling purposes in connection with the milling of minerals from any valid mining claim situated within the Misty Fjords or Admiralty Island National Monuments.

(2) A lease may be issued under this subsection if the Secretary determines-

(A) that the use of the site to be leased will not cause irreparable harm to the Monument; and

(B) that the use of such leased area for such purposes will cause less environmental harm than the use of any other reasonably available location.

(3) A lease under this subsection shall be subject to such reasonable terms and conditions as the Secretary deems necessary.

ation. (4) A lease under this subsection shall terminate-

(A) at such time as the mineral deposit is exhausted; or

(B) upon failure of the lessee to use the leased site for two consecutive years unless such nonuse is waived annually by the Secretary.

(g) ACCESS TO MINING CLAIMS.-The holder of an unperfected mining claim with respect to which a valid mineral discovery is made under an exploration permit under this section shall be entitled to the same access rights as the holder of a valid

. 2464. mining claim is entitled to under section 1110. The holder of the unperfected claim with respect to which an exploration permit is in effect under this section shall be entitled to such adequate access, as described in section 1110 as may be necessary to carry out exploration under such permit.

(h) PUBLIC NOTICE.-The Secretary shall provide public notice of the requirements of this section not later than ninety days after the date of the enactment of this Act.

(i) SAVINGS PROVISION.-

(1) Nothing in this section shall impair any valid existing right.

(2) Nothing in this section diminishes authorities of the Secretary under any other provision of law to regulate mining activities.

(3) Nothing in this section shall be construed to affect, in any way, any other provision of Federal law outside the State of Alaska.

(j) This section shall not apply to any unperfected mining claim which is located within one mile of the center line of the Blossom River from its headwaters to its confluence with the Wilson Arm.

FISHERIES ON NATIONAL FOREST LANDS IN ALASKA

Regulations.
16 USC 539b.

SEC 505. (a) The Secretary of Agriculture shall, in consultation with the Secretaries of Commerce and the Interior, and with the State of Alaska, pursuant to his existing authority to manage surface resources, promulgate such reasonable regulations as he determines necessary after consideration of existing laws and regulations to maintain the habitats, to the maximum extent feasible, of anadromous fish and other foodfish, and to maintain the present and continued productivity of such habitat when such habitats are affected by mining activities on national forest lands in Alaska. The Secretary of Agriculture, in consultation with the State, shall assess the effects of the populations of such fish in determinations made pursuant to this subsection.

Assessment.

Approved plan operations, requirement.

(b) Because of the large scale of contemplated mining operations and the proximity of such operations to important fishery resources, with respect to mining operations in the Quartz Hill area of the the Tongass National Forest, the regulations of the Secretary shall, pursuant to this subsection, include a requirement that all mining operations involving significant surface disturbance shall be in accordance with an approved plan of operations. Before approving any proposed plan or distinct stages of such plan of operations for any such claims when any fishery habitat or fishery value may be affected, the Secretary shall, in consultation with the Secretaries of Commerce and the Interior and the State of Alaska, determine-

(1) that such plan or stages of such plan are based upon and shall include studies or information which he determines are adequate for-

(A) evaluating the water quality and water quantity, fishery habitat, and other fishery values of the affected area; and

(B) evaluating to the maximum extent feasible and relevant, the sensitivity to environmental degradation from activities carried out under such plan of the fishery habitat as it affects the various life stages of anadromous fish and other foodfish and their major food chain components;

isk and benefit identification.

(2) that such plan adequately identifies the risks the operations under such plan or such stages might pose to and the benefits the operations under such plan might provide to-

(A) the natural stability and the present and continued productivity of anadromous fish and other foodfish;

(B) fishery habitat, including but not limited to water quality and water quantity; and

(3) that such plan includes provisions which he determines are adequate for the purposes of-

(A) preventing significant adverse environmental impacts to the fishery habitat (including but not limited to water quality and water quantity) or other fishery values; and

(B) maintaining present and continued productivity of the habitat of anadromous fish and other foodfish which might be affected by the mining and other activities proposed to be conducted in accordance with such plan or such stages of the plan of operations;

(4)(A) the Secretary shall ensure, to the maximum extent feasible, that the cumulative effects of activities carried out under the operating plan will not interfere with the ability to collect baseline information needed by the Secretary to evaluate the effects of various stages of the operating plan on the fishery habitat and productivity of such habitats;

Review.

(B) The secretary shall review such plan and mining activities on at least an annual basis. With respect to any mining or associated activities, the Secretary, if he determines upon notice and hearing, that the activities are harmful to the continued productivity of anadromous fish, or other foodfish populations or fishery habitat, shall require a modification of the plan to eliminate or mitigate, if necessary, the harmful effects of such activities; and

Activity suspension.

(5) upon a finding by the Secretary that a mining activity conducted as a part of a mining operation exists which constitutes a threat of irreparable harm to anadromous fish, or other foodfish populations or their habitat, and that immediate correction is required to prevent such harm, he may require such activity to be

suspended for not to exceed seven days, provided the activity may be resumed at the end of said seven-day period unless otherwise required by a United States district court.

(c) Nothing in this section shall enlarge or diminish the responsibility and authority of the State of Alaska to manage fish and wildlife or to exercise its other responsibilities under applicable laws.

(d) Except as specifically provided in subsection (b)(5), nothing in this section shall enlarge or diminish the responsibilities and authorities of the Secretary of Agriculture to manage the national forests.